

GOVERNMENT OF MALAYSIA

**FEASIBILITY STUDY
ON
RATIONALIZATION AND
CROP DIVERSIFICATION
IN
NON-GRANARY IRRIGATED AREAS
IN MALAYSIA**

Volume 5-3

State Report - P. Pinang

October 1990

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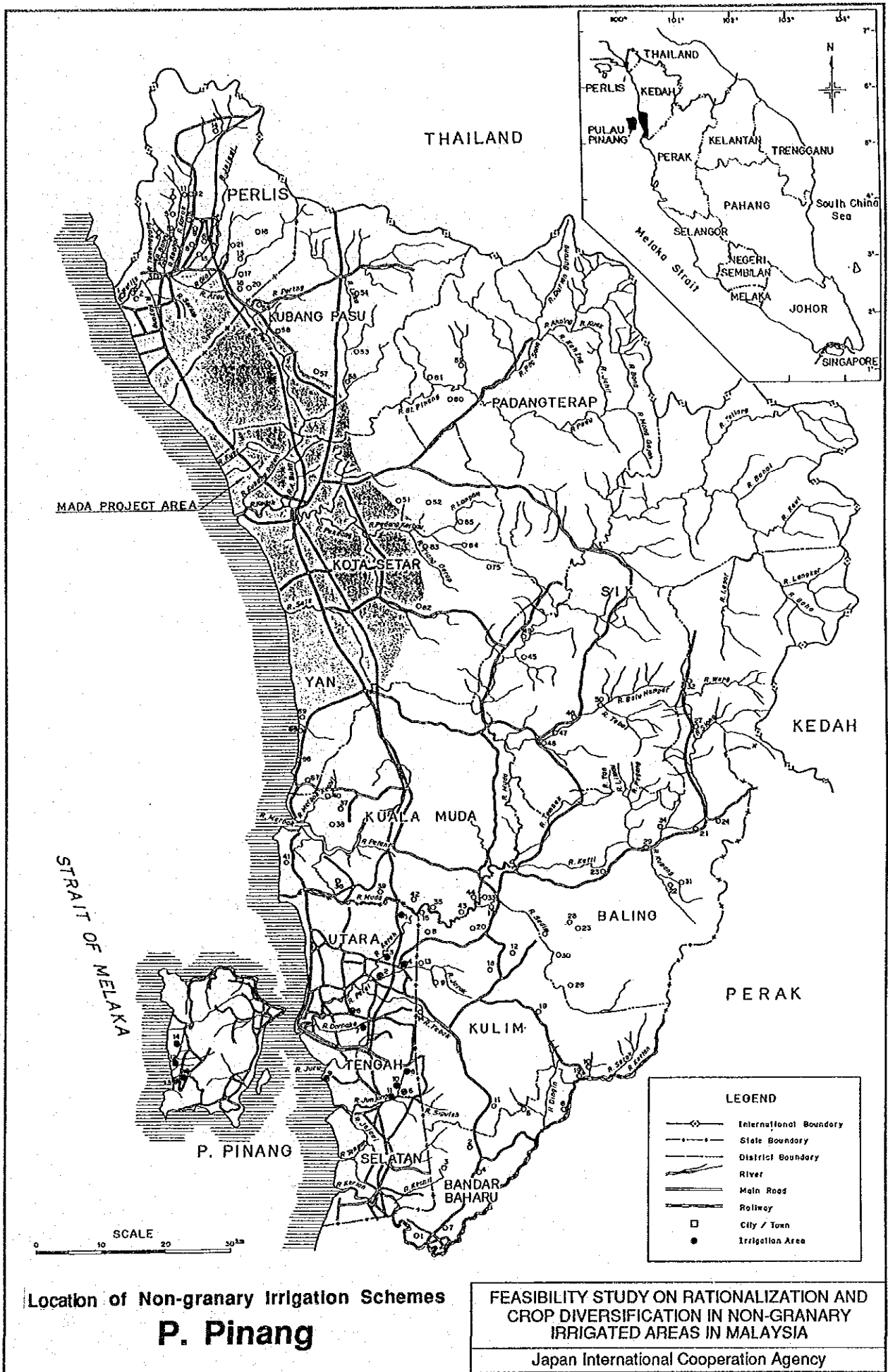
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*Feasibility Study on Rationalization and Crop Diversification
in Non-granary Irrigated Areas in Malaysia*

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Volume 5-3

State Report - P. Pinang

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RESULTS OF EVALUATION FOR CROP DIVERSIFICATION POTENTIAL

1. INTRODUCTION

This is the State Report - P. Pinang, Volume 5-3, of the Final Report for Feasibility Study on Rationalization and Crop Diversification in Non-granary Irrigated Areas in Malaysia. This report includes the criteria, procedure and results of evaluation of crop diversification potential of non-granary irrigation schemes in the State of P. Pinang.

Detailed information on the criteria and procedure for evaluation is presented in Volume 2 of the Final Report, and the results of evaluation of crop diversification potential for each scheme are given in the Appendix attached to this Volume.

2. GENERAL CONDITIONS

2.1 Socio-economic Situation

Pulau Pinang consists of the island of Penang and a strip of land on the mainland opposite known as Seberang Perai, bounded by Kedah to the north and east and by Perak to the south. The total area is 1,031 km² of which the island occupies 285 km². The State is divided into five administrative districts. The estimated population was 1,053,300 persons for 1985 and 1,103,100 persons for 1988. The population density in 1988 was 1,070 person/km². Rural population ratio declined 46% in 1985 to 42% in 1988. The proportion of population by ethnic group in Pulau Pinang was 53% for Chinese, 54% for Bumiputera, 12% for Indian and 1% for others in 1987.

In the State of Pulau Pinang, GDP in 1988 totalled M\$4,713 million at 1978 constant prices of which only 4% was derived from the agriculture sector. The largest contributor to GDP was the manufacturing sector with the share of 45% followed by the service sector of 21%. Per capita GDP rose from M\$3,723 in 1986 to M\$4,222 in 1988, both of which were above the nation average of M\$3,551 in 1986 and M\$3,858 in 1988. According to the Household Income Surveys, the State had 27,400 poor households or 13.4% of the total of 204,500 households in 1984 and 28,200 poor households or 12.9% of the total of 218,600 households in 1987. The mean monthly income went up M\$1,183 in 1984 to M\$1,130 in 1987, both exceeding over Peninsular Malaysia's average of M\$1,095 in 1984 and M\$1,074 in 1987.

Regarding social infrastructure conditions in 1985, the coverage of electricity services was 81% of the total population. In urban areas 98% of the people received piped water services, while in rural areas the service ratio was 85%. The road network was 1,324 km in the total length and its density was 1,280 m/km² with per capita road length of 1,260 m every 1,000 population. In the State, 348 motor vehicles were registered per 1,000 population. There were 4.6 doctors

and 2.9 acute care hospital beds per 1,000 population. Each health center took care of 34,100 rural people. The infant mortality rate was 1.0 per 1,000 population.

Under the revised 5MP, a total of M\$739 million was allocated to the State as the development expenditure of the Federal Government and NFPEs accounting for 2.4% of the total expenditure for all the States. Apart from State Government agencies, another authority playing a role in the State's development is the Penang Regional Development Authority (PERDA). Its main objective is to help the rural poor through agriculture and poultry projects. So far PERDA has identified 27 areas for development up to the end of 1990 and up to now eight of the 27 areas have been moved in the development stage. These 27 areas comprise nine integrated schemes of traditional villages and 18 growth centers. The Penang Development Corporation (PDC) is an authority to initiate and monitor industrial development in the State. Actually, PDC is involved in industrial promotion and development, tourism promotion, urbanization and urban renewal, and in projects aimed at upgrading the socio-economic well-being of the people.

2.2 Present Agriculture

In Pulau Pinang, there exists agricultural land occupying about 72,800 ha as a whole or accounting for 71% of the whole land. Of these, a total of 45,800 ha is under tree crops, including abandoned tree crop areas to considerable extent due to rapid urbanization in the State. At present, productive tree crop areas consist of 7,940 ha under oil palm, 5,170 ha under coconut, 3,420 ha under rubber and 70 ha under cocoa. Blessed with high-consuming areas, fruit cultivation is prosperous and among others durian is grown in an area of 1,787 ha accounting for 28% of miscellaneous crop areas of 6,429 ha as a whole. In the State, some 77 crops are grown at present. In 1987, the State produced paddy of 52,400 tons, oil palm of 97,000 tons as FFB and rubber of 22,700 tons.

According to the projection made by FAMA, the total demand for food crops, vegetables, fruits and freshwater fishes is summarized below.

Produce	Net Consumption (ton)	Outflow to Other States (ton)	Post-harvest Loss (ton)	Total Demand (ton)
Food crops	3,140	371	1,592	5,103
Vegetables	88,118	2,281	22,600	112,999
(Leafy)	(31,148)	(1,381)	(8,132)	(40,661)
(Fruit)	(34,299)	(545)	(8,711)	(43,555)
(Root)	(12,363)	(212)	(3,144)	(15,719)
(Other)	(10,308)	(143)	(2,613)	(13,064)
Fruits	45,581	57	11,410	57,048
Freshwater fishes	363	0	91	454

The projected supply quantity is 3,802 tons for food crops, 6,150 tons for vegetables, 4,399 tons for fruits and 66 tons for freshwater fishes. The State has thus the marketing potential as indicated below.

Produce	Market Potential (ton)	Major Crops (ton)
Food crops	3,433	Sweet potato (2,085), Taro (1,075)
Vegetables	106,849	
(Leafy)	(39,449)	Cabbage (11,093), Chinese kale (9,707)
(Fruit)	(38,617)	Chilli (7,286), Tomato (6,104)
(Root)	(15,719)	Carrot (9,681)
(Other)	(13,064)	Garlic (6,058)
Fruits	52,465	Banana (10,764), Watermelon (9,710)
Freshwater fishes	451	River catfish (133)

2.3 Present Situation of Non-granary Irrigation Schemes

In Pulau Pinang, there exists agricultural land occupying about 72,800 ha as a whole or accounting for 71% of the State. The total paddy fields are 17,815 ha. A total of 45,800 ha is under tree crops and due to rapid urbanization in the State productive tree crop areas consist of 7,940 ha under oil palm, 5,170 ha under coconut, 3,420 ha under rubber and 70 ha under cocoa. Blessed with high-consuming areas, fruit cultivation is prosperous and among others durian is grown in an area of 1,787 ha. The total miscellaneous crop area are 6,429 ha in which some 77 crops are grown at present. The irrigable paddy fields are 16,541 ha in total comprising the Balic Pulan/Sekerang Perai granary area of 13,000 ha and non-granary irrigated areas of 3,541 ha.

- Number of schemes : 14
- Irrigable area : - main season = 3,541 ha
- off season = 3,541 ha
- Type of schemes : gravity; 5 pump; 5
gravity/pump; 2,
Controlled drainage; 1,
inundation; 1
- Irrigation water resources availability by scheme
(except controlled drainage and inundation schemes)
 - : - sufficient for double cropping; 1
 - insufficient for off season
presaturation; 5
 - limited to only single cropping; 2
- Average cropping intensity (paddy + upland crops)
for previous three years (1985-1987)
 - : - main season = 83%
 - off season = 82%
- Average cropping intensity (paddy only)
for previous three years (1985-1987)
 - : - main season = 76%
 - off season = 75%
- Utilization of scheme : - Main season paddy cropping
intensity of 100%; 3

- Main season paddy cropping intensity of more than 50%; 6
- Main season paddy cropping intensity of less than 50%; 5

In 1986, a Master Plan for Agricultural Development of the State of Pulau Pinang was prepared by MOA. In this plan, the existing paddy fields were grouped into two categories. One is demarcated as high productive paddy fields to be maintained, while the other is delineated as paddy fields suitable for promoting crop diversification.

Although the average cropping intensity is less than 50%, double cropping is popularized in the maintained paddy fields coupled with improvement of farm road network, rationalization of water management and strengthening of supporting services under the Balik Pulau/Seberang Perai IADP. Further, revitalization of idle paddy field is under encouragement. Some 41 farmers have succeeded their group farming system to grow vegetables using sprinkler irrigation. In general, there is no hindrance on promoting crop diversification because the State Government and local community leaders have clear guideline policy on effective utilization of farm land.

The State Agriculture Committee has studied the possibility of introducing the two cropping system as the first step of crop diversification in paddy fields where farmers currently grow paddy only. Among problems to be solved, effective method of drainage improvement is required to be established in promoting crop diversification.

3 EVALUATION OF CROP DIVERSIFICATION POTENTIAL FOR NON-GRANARY IRRIGATION SCHEMES

This section presents a general concept, criteria and procedure of evaluation in order to facilitate understanding of the results of the evaluation of potential for crop diversification by scheme attached in Appendix of this volume. A detailed explanation of the evaluation is given in Volume 2.

3.1 Basic Considerations for Evaluation

The intended shift from paddy cultivation to diversified crops in non-granary irrigated areas would invariably require investigations on a range of issues such as the selection of the appropriate crops based on agronomic and economic factors, institutional support systems, and additional investments for providing new or upgrading of facilities. Since the areas concerned are both extensive and widespread, it is only proper that a coordinated study be carried out in order to evaluate the prevailing scheme conditions and to prepare crop diversification strategies including the selection of the suitable crops.

To prepare crop diversification options for revitalization of the non-granary irrigation schemes with a wide range of constraints, the potential for crop diversification in each scheme area has to be evaluated and then indicated as the crop diversification patterns. Such procedure is to be defined as evaluation of resource potential for crop diversification. Its outcome will provide indications of the crop diversification patterns being a basis for formulating development plans and programs.

For non-paddy crops, irrigation has recently become an important input for crop production in Malaysia like irrigation for paddy. In order to accommodate crop diversification in the existing rice-based irrigation systems, special considerations are required for

the differences between paddy and non-paddy crops as well as paddy farmers behavior in addition to basic parameters such as soil-plant-water relations, water resources, climate, geographic, economic and social.

3.1.1 Differences between paddy and non-paddy crop

Paddy is very tolerant to fully saturated or flooded conditions, which is the main reason for it being planted in flood prone areas with heavy soils and poor drainage conditions. Non-paddy crops on the other hand need non-saturated and well aerated soils for healthy growth. Therefore poorly drained areas as found in most of the schemes can seriously affect growth and yields of non-paddy crops.

Sensitivity to water stress varies between their growth stages and also crop types. Cultural practices and production systems can be vastly different between types and varieties and the produce also tend to be more perishable than paddy.

These basic differences need some general criteria for the system design to be established. Irrigation for paddy is designed for continuous supply and drainage adequate for excess surface flow. Whereas for non-paddy, supply is intermittent since demand depends on available soil water storage and evapotranspiration rate. Besides irrigation, water is also required for fertilizer and pesticide application for non-paddy crops. Its drainage design will need to consider both surface and subsurface flows.

3.1.2 Paddy farmers' behavior

Paddy areas have a very long history of mono-cropping, and traditions and culture have evolved around paddy. Most paddy farmers are usually experienced and knowledgeable only in paddy production. Thus, diversification will require changes to deep-rooted life styles, values and technology of paddy farmers. On the other hand,

diversification will also require appropriate adjustments on its part to match with their behavior.

In this connection, a Socio-economic Sample Survey was performed in all non-granary irrigation scheme areas to identify paddy farmers' intentions and local community opinion leaders' view towards crop diversification. The results of the Socio-economic Sample Survey are presented in Appendix B for farmers' intentions and Appendix C for the leaders' opinions.

3.1.3 Determination of categories

In deciding options for crop diversification, it is apparent that there exists various possibilities for diversifying land utilization such as double cropping of paddy, combination of the main season paddy with short-term crops in the off-season, mix-farming, perennial tree crop cultivation, freshwater aquaculture, and cattle grazing ground. Any one of these taken singly or in combination with any other option can be a category. Taking into consideration the purpose of the evaluation under the Study, the following eight categories are to be made:

- Category 1 : Schemes to be converted to high value crop cultivation under irrigated condition,
- Category 2 : Schemes to be converted to tree crop cultivation;
- Category 3 : Schemes to introduce two-cropping system planting paddy during the main season and short-term annual crops during the off-season;
- Category 4 : Schemes to be converted to animal feeding crop cultivation or cattle raising fields;
- Category 5 : Schemes to be converted to freshwater fish culture ponds;
- Category 6 : Schemes to be positively maintained as mini-granary areas;
- Category 7 : Schemes to be maintained as paddy cultivation areas within a definite period of time for social welfare purposes and thereafter to be further categorized; and
- Category 8 : Schemes to be converted to housing/industrial and other uses.

3.2 Criteria for Evaluation

3.2.1 General

Inevitably, crop diversification involves the question of which crop or crops to be recommended based on a variety of factors. In the process to evaluate potential for crop diversification, each non-granary irrigation scheme is subjected to a screening process on a variety of factors. For this purpose, seven main factors are taken into account.

- Water resources availability,
- Farmers' intention towards continuation of paddy cultivation and introduction of crop diversification,
- Land suitability for carrying out direct seeding and mechanized plowing and harvesting for growing paddy,
- Soil and climatic suitability and limitations for the cultivation of specific crops,
- Crop profitability,
- Crop marketability, and
- Investment performance with regard to crop diversification.

3.2.2 Water resources availability

The evaluation of water resources in quantitative and qualitative terms is based on the information collected during the Scheme Inventory Survey. Reconfirmation of water resources availability is carried out through supplementary investigations on rainfall data, catchment characteristics, river discharges, reference on the existing hydrological procedures, and previous study reports on the availability of water resources on a specific catchment. The criteria for evaluating water availability of each non-granary irrigation scheme is expressed in the following four terms:

- A. Irrigation water is sufficient for double cropping of paddy;
- B. Sufficient for supplying irrigation water to the main season paddy cultivation but insufficient for meeting presaturation water requirement for the off season paddy cultivation;
- C. Limited to single cropping of the main season paddy and upland crop cultivation; and
- D. Insufficient for paddy cultivation but no limitation to grow upland crops for the main season.

The detailed information on water resources evaluation for the various non-irrigation schemes is compiled in Appendix A of Volume 2.

3.2.3 Farmers' intention towards continuation of paddy cultivation and introduction of crop diversification

This factor is important as the success of the crop diversification program is depended on farmers' willingness to participate and also their attitude and preference to move towards a more diversified cropping pattern. To evaluate this factor, the Socio-economic Sample Survey results are referred to in respect to paddy farmers' intention towards continuation of paddy cultivation and introduction of crop diversification.

The evaluation criteria established are based on the proportion of respondent farmers who strongly intend to continue the present paddy cultivation pattern among the total sample farmers and that of paddy planted area for the last three years (1985-1987) against the irrigable area of each scheme. The evaluation method is to identify the State in which more than half of the respondent farmers show intentions towards continuation of paddy cultivation and to screen out the scheme with paddy cropping intensity of more than 50%.

- Schemes possible for promoting double cropping of paddy in case that the proportion of intended farmers against the total samples in each State is over 50%. Also, possible for promoting double cropping of paddy if the scheme-by-scheme planted area for the last three years is more than 50% every year in case of the State with the above proportion of less than 50%.

- Schemes impossible for promoting intensive paddy cultivation when the above proportion on the State basis is less than 50% and the cropping intensity is below 50%.

3.2.4 Land suitability for mechanized farming practices

This factor is optionally evaluated to clarify suitability of undertaking modern farming practices of paddy cultivation in case of schemes where intensive double cropping of paddy can be promoted. To evaluate this factor, special attention is paid to soil physical characteristics, size of scheme, availability of mechanical service centers and distance between schemes and available service sources. The evaluation criteria is established taking into account soil physical characteristics among others as below.

- Schemes suitable for mechanized farming practices are expressed in terms of the existence of alluvial soils.
- Schemes not suitable for mechanized farming practices are indicated by inappropriate soil physical conditions derived from peat soils and organic mac soils which are featured by low bearing capacity for using tractors and harvesters commonly used in Malaysia.

The detailed information is presented in Appendix D of Volume 2.

3.2.5 Soil and agro-climatic suitability and limitations for the cultivation of specific diversified crop

These factors are the basis to identify crops suitable for each scheme from the agronomic viewpoints. In identifying suitable crops, soil criteria for optimum crop growth is prepared for the following 28 crop groups referring to documents such as "Soil-Crop Suitability Classification for Peninsular Malaysia" prepared by the Department of Agriculture (DOA), "The Land Capability Classification" collected from DOA, Sabah and "Sarawak Land Capability Classification and Evaluation for Agricultural Crops" issued by DOA, Sarawak.

Short-term food crops:

maize, sorghum, wet paddy and upland rice as food crops, and ginger, groundnut and vegetables as vegetable crops,

Fruits:

mango/durian, guava, banana, cashewnut, papaya, citrus, pineapple and watermelon,

Perennial industrial crops:

coconut, oil palm, cocoa, rubber, sago palm, coffee, tea, clove, tobacco, sugarcane and pepper,

Feeding crops:

fodder grasses and pasture.

As the basic information to evaluate soil suitability and limitations, soil services that distribute in each scheme are identified referring to the available reconnaissance soil maps and those limitations to growth of each of 28 crops are evaluated on the basis of the soil criteria. The evaluated limitations are expressed in the form of soil suitability classed with a symbol indicating the specific limitation such as acid sulphate layer, depth to compacted layer, drainage, nutrient imbalance, organic horizon, salinity, and texture and structure. The followings are the grade of limitations to crop growth.

- Class 1 soils with no limitation or only minor limitations to crop growth are suitable for the widest range of crops.
- Class 2 soils with moderate limitations to crops growth are suitable for a narrower range of crops than Class 1 soils. Minor management practices according to limitations are required.
- Class 3 soils with one serious limitation to crop growth are restricted to an even narrower range of crops. Necessary management practices involve moderate expenses.
- Class 4 soils with more than one serious limitation to crop growth are suitable for a very narrow range of crops with provision of major amelioration measures.
- Class 5 soils with at least one very serious limitation to crop growth are least suitable for crop growth.

Through the identification and grading of limitations to crop growth for soil series which is identified in each non-granary irrigation scheme, soil suitability of 28 crops is classified into four groups such as suitable, marginally suitable, very marginally suitable and not suitable for promoting crop diversification.

The correlation between suitability grades and soil classes as follows:

Suitable:

Class 1 soils,

Marginally suitable:

Class 2 soils and partly Class soils of which limitations can be physically improved,

Very marginally suitable:

Class 3 soils with limitations of which limitations can be hardly graded up by direct physical measurements, and

Not suitable:

Classes 4 and 5 soils.

After evaluating soil suitability in the above procedure, identified crops with suitable to very marginally suitable grades are to be succeedingly confirmed from the agro-climatic viewpoint. For this purpose, two basic references are utilized, being "Agro-ecological regions in Peninsular Malaysia" and "Climatic and Agricultural Planning in Peninsular Malaysia" both prepared by the Malaysian Agricultural Research and Development Institute (MARDI). Among the identified crops, those which are not suited to regional climatic conditions in the specific scheme are eliminated from a list of suitable crops identified on the basis of soil conditions.

The detailed information is presented in Appendix D of Volume 2.

3.2.6 Crop profitability

To confirm the net income difference between paddy cultivation and other diversified crops, crop budget is computed based on average crop yield under normal farming practices, production cost and selling price. For this, "Guideline on Economic Viability of Selected Crops" prepared by the Ministry of Agriculture (MOA) is used as the basic reference. This includes crop budget data on 25 food crops and vegetables, 14 fruits and one industrial crop. With regard to other industrial crops, data on crop budgets are supplemented from MOA, DOA and agencies concerned. All the information is presented in Appendix E of Volume 2. The evaluation criteria is set up as below.

- Crop suitable for promoting diversified cropping are more profitable as compared with net income derived from the single cropping of paddy.
- Crops not suitable for incorporating in diversified cropping are less profitable in comparison with the net income obtained from the single cropping of paddy.

3.2.7 Crop marketability

This factor is also very important when crop diversification is promoted in specific areas, because most paddy farmers are aware that success of diversified cropping especially for short-term upland crops demand largely on availability of markets where they can expect to sell their produce at profitable price levels.

In terms of export-oriented perennial crops, the respective responsible agencies provide smallholder farmers with easy access to the existing marketing channel actively maintained. As for short-term upland crops, the Federal Agricultural Marketing Authority (FAMA) is responsible for promotion of marketing activities to encourage growers. Every year, FAMA gives a guideline for market potential in each State for about 30 varieties of vegetables and cash crops, 20 varieties of fruits and 15 kinds of freshwater fishes and livestock products. The data on market potential is compiled in Annex F of

Volume 2. By referring to this guideline, the crop marketability is evaluated in terms of quantified market potential on the administrative district-by-district bases. The evaluation criteria is set up as below.

- Crops suitable for promoting crop diversification have less marketable volume as compared with the demand of a specific administrative district where one particular scheme is located major market situated nearby or easily accessed from the scheme.
- Crops not suitable for promoting crop diversification have marketable quantity exceeding over more than twice of the demand in the specific administration district.

3.2.8 Investment performance with regard to crop diversification

This factor is evaluated for the purpose of judging the priority among categories and crops of which suitability to promote crop diversification are both identified. The evaluation procedure is based on economic viability indicated by net present value and benefit-cost ratio.

3.3 Procedure of Evaluation

3.3.1 General procedure

The potential of crop diversification for each non-granary irrigation scheme is evaluated category by category based on the following seven stepwise procedure as illustrated in Fig. 1.

Step 1 : Evaluation water resources availability,

Step 2 : Evaluation of farmers' intention towards continuation of paddy cultivation and introduction of crop diversification,

Step 3 : Evaluation of land suitability for carrying out direct seeding and mechanized plowing and harvesting in growing paddy,

Step 4 : Evaluation of soil and climatic suitability and limitations for the cultivation of specific crops,

Step 5 : Evaluation of crop profitability,

Step 6 : Evaluation of crop marketability, and

Step 7 : Evaluation of investment performance with regard to crop diversification.

The flow chart of evaluation procedure is illustrated in Fig. 2. In general, evaluation of factors in each Category starts from Step 1 and ends Step 7 for the respective schemes. As Step 3 is the optional gate to evaluate land suitability for conducting mechanized paddy cultivation practices, all Categories other than Category 6 jumps evaluation in Step 3. Before entering Step 1, the following two items are preliminarily checked to understand the present condition on how a scheme is utilized by beneficially farmers:

- Type of irrigation water intake facilities, and
- Planted area for the last three years.

3.3.2 Evaluation procedure for Category 1

In Step 1, one scheme has potential for promoting intensive short-term upland crop cultivation under irrigated condition if available water resources are enough for double cropping of paddy and short during the presaturation period of the off season. Upland crops can be grown maximum twice a year under irrigated condition in case that available water resources can meet irrigation water demand only for the main season paddy. Irrigated cropping of upland crops are limited to the main season if available water resources are insufficient for paddy cultivation. Therefore, each scheme can pass Step 1 with the exceptions of control drainage and inundation schemes.

In Step 2, schemes are evaluated as possible for promoting crop diversification and then go to Step 4. To provide information on technical and economical choice of upland crops if requested, other schemes also move down to Step 4 additionally.

In Step 4 after skipping Step 3, suitable upland crops are firstly identified through soil-crop-suitability assessment. Further, suitable varieties of upland crops are selected among the above crops identified paying special attention agro-climatic condition in lowland areas. If there is an identified and selected crop, schemes enter into the next step.

In Step 5, net income data of the selected crops are compared with that earned from single cropping of paddy. In case of higher net income expected, schemes shift to the next step.

In Step 6, marketability of upland crops confirmed its profitability are evaluated through comparison with the local demand in the District where schemes are located and in the local marketing centers. Usually, mono-cropping of the specific upland crop is very risky from the viewpoints of crop management and marketing. In this connection, crop production is estimated based on such assumed figures as the national average yield and the maximum planted area equivalent to 50% of the scheme's irrigable area for each of profitable crops.

In Step 7, economic viability is evaluated in terms of benefit-cost ratio and net present value. For this, benefit and cost are estimated on the basis of the assumption as below. The result is used for determining the priority among marketable upland crops and in comparison with other categories.

- Cost and benefit are estimated on the unit area basis,
- Cost required for upgrading drainage and access conditions is assumed to be M\$8,000/ha and time required for constructing these on-farm service facilities is one year, and
- Benefit born before diversification depends on single cropping of paddy and after diversification comes from marketable upland crops in the same planted area of paddy. Crop budget figures refer to those used in evaluating crop profitability. Buildup period to reach the target yields of upland crops is also assumed to be five years.

3.3.3 Evaluation procedure for Category 2

In Step 1, consideration is given only to improve drainage and farm access conditions for evaluating potential for converting paddy fields to perennial crop fields. Thus, all the schemes except control drainage and inundation types go to the next step.

In Step 2, the same procedure taken for Category 1 is applied and therefore schemes jump Step 3 and enter to Step 4.

In Step 4, suitability of fruit and industrial tree crops is assessed from the viewpoint of soil-crop suitability relationship. Then, identified tree crops as suitable are evaluated on the basis of agro-climatic condition of each scheme. When a tree crop is identified and selected, schemes shift to the next step.

In Step 5, annualized net income is calculated according to the economic life of a tree crop and then compared with net income gained from single cropping of paddy. If the annualized income is higher, schemes enter into the next step.

In Step 6, profitable tree crops are evaluated to confirm those marketability as compared with local demand on the administrative district basis firstly and in major markets secondly. Crop production amount is equal to the annualized yield used for estimate of crop profitability.

In Step 7, the same procedure as taken for Category 1 is applied. Cost required for upgrading drainage and farm access conditions is assumed to be M\$4,000/ha for scheme of which soils have marginally drainage limitation to crop growth and M\$8,000/ha for the case of very marginally drainage limitation.

3.3.4 Evaluation procedure for Category 3

In Step 1, schemes with sufficient water resources for the main season paddy cultivation are identified as possible schemes where two cropping system can be promoted. While, schemes with water shortage problems during the main season are deleted from further evaluation in Step 2 and onward.

In Step 2, schemes that are evaluated as possible for promoting crop diversification and intensive double cropping of paddy go to Step 4. In case of schemes with no possibility of improving the present paddy cultivation pattern, further evaluation in Step 4 and onward is made to get information on suitable crops with those profitability and marketability as reference data.

In Step 4 after skipping Step 3, short-term upland crops suitable for the off season cultivation are identified resulting from assessment of soil-crop-suitability. Then, crop selection is made after confirming crop adaptability to agro-ecological situation in each scheme. If there is identified and selected crop, schemes move to the next step.

In Step 5, net income of the main season paddy is estimated taking into account increase in average unit yield from 2.25 ton/ha to 3.5 ton/ha through improvement of farming practices. The off season upland crops have the same yield level of Category 1.

In Step 6, evaluation of marketability is made for the off season upland crops by applying the similar method to Category 1.

In Step 7, additional investment requirement is assumed to be M\$4,000/ha. Benefit estimate and economic viability confirmation are made following the same procedure employed for Category 7.

3.3.5 Evaluation procedure for Category 4

In Step 1, no attention is paid to availability of water resources so that all the schemes can pass this step.

In Steps 2 and 3, no evaluation of these two factors is made as possibility of introducing this Category is examined from the technical and economical viewpoints.

In Step 4, soils with excessively drained feature are evaluated as possible for converting paddy fields to animal grazing land. In case of growing animal feeding crops, those suitability is assessed from the soil-crop-suitability assessment. When both results indicate as suitable for conversion of paddy fields for the livestock purpose, schemes go to the next step.

In Step 5, profitability is evaluated focussing upon the contribution of both grazing and feeding practices to livestock outputs. For this purpose, the average annual income is estimated based on beef production value obtained from unit yield of animal feeding crops. If the profit is higher than that derived from single cropping of paddy, schemes enter into the next step.

In Step 6 and , marketability is evaluated with the same procedure of Category 1.

In Step 7, additional investment cost is assumed to be M\$500/ha for the use of paddy fields to rear animals and M\$4,000/ha for growing animal feeding crops. Benefit is estimated referring to the result of profit evaluation.

3.3.6 Evaluation procedure for Category 5

In Step 1, special attention is paid to availability of sufficient water resources to meet daily freshwater requirement. If the available water resources are enough to grow paddy twice a year, schemes enter into the next step. For the case of control drainage schemes located along the coast in Sarawak, intake of brackish water is evaluated according to topographic condition.

In Steps 2 and 3, all the schemes with sufficient water resources skip these two steps with the same reason of Category 4.

In Step 4, soils with heavy texture are prerequisite to convert paddy fields to fish ponds. From the agro-climatic viewpoints, schemes with no effect of flooding are recognized as possible for promoting freshwater fish pond culture. Schemes that can pass these two checking points move to the next step. In case of brackish water fish culture, flooding or excess inundation problem is only assessed.

In Step 5, profitability is evaluated on the basis of annualized net income earned from carp, freshwater shrimp and brackish water prawn cultures by in excavated fish pond with modern practices. If higher profit is expected as compared with single cropping of paddy, schemes shift to the next step.

In Step 6, the evaluation procedure of marketability is the same as Category 1.

In Step 7, required cost for excavating fish pond is assumed to be M\$10,000/ha. Benefit is estimated by referring to the profitability evaluation results.

3.3.7 Evaluation procedure for Category 6

In Step 1, supply of irrigation water for the off season is the most important key factor for this category. Schemes pass this step if available water resources can meet the normal irrigation water demand for the off season paddy.

In Step 2, schemes evaluated as possible for promoting double cropping of paddy enter into the next step.

In Step 3, land suitability for performing mechanized farming practices is evaluated. Schemes identified as suitable pass this step and go to the next step.

In Step 4, soil and agro-climatic suitabilities are reconfirmed and schemes with no limitation shift to the next step.

In Step 5, assumption is made in terms of increase in unit yield of paddy from 2.25 ton/ha to 3.5 ton/ha per one season. Schemes pass this step.

In Step 7 after skipping Step 6, cost is assumed to be M\$4,000/ha to improve on farm-service facilities matching with undertaking of mechanized farming practices. Benefit estimate is made referring the results of profitability evaluation.

3.3.8 Evaluation procedure for Category 7

Evaluation of potential for the Category 7 is to be made in case that a scheme is presently used for the paddy cultivation purpose and no potential use for the Categories 1 to 6 is identified.

In Step 1, schemes with available water resources for the main season paddy cultivation goes to the next step.

In Step 2, schemes shift the next step if identified as impossible for promoting crop diversification from the social viewpoint.

In Step 4 after skipping Step 3, soil limitations to growth of paddy are reconfirmed. If schemes have poorly drained soils caused by frequent flooding and stagnant water problems, these are deleted from further evaluation. In this connection, inundation and controlled drainage schemes can be taken into consideration only for the case that more than half of the irrigable area is grown with paddy for the last three years. All the schemes that pass this step are identified as Category 7 without further evaluation of factors in Step 5 and onward.

3.3.9 Evaluation procedure for Category 8

If no crop diversification potential is found through evaluation for the Categories 1 to 7, the following factors are to be evaluated. These are water availability and soil limitation to crop growth. Schemes with *no available water resources and unsuitable soils for crop growth* are defined as Category 8.

4. RESULTS OF EVALUATION

The evaluation results of crop diversification potential are adjusted to agro-climatic factors, regional market demand for diversified crops and investment performance. The State of Pulau Pinang is included in one agro-ecological zone, Region 3. This regional climate has the advantages in growing perennial crops as described in Appendix D of Volume 2. Taking into account regional climatic suitability, recommendable crops are selected with the priority order as shown in Table 1 and some of crops judged as suitable in each step of the potential evaluation are deleted. In harmony with the State's agricultural policy, the special attention needs to be paid to stepwise promotion of crop diversification in middle scale irrigation schemes.

If marketable quantities of specific crops produced in one non-granary irrigation scheme is over the local demand within an administrative district, possibility of marketing to larger consumption centers, Georgetown and Kuala Lumpur, is examined by comparing surplus of marketable quantities with the regional market demand.

As a result of the above process, the crop diversification potential is adjusted to the present condition category by category for each scheme. Table 2 shows the summary of crop diversification potential evaluation. The process of evaluation is attached to this Volume 5 as Appendix in a form of scheme-by-scheme description sheet.

Among 14 non-granary irrigation schemes, as shown in Table 2, six schemes are given with the Category 1 as the super category. With provision of regional marketing promotion activity, potential for irrigated upland crop cultivation can be expected in another five schemes. With respect to five middle scale schemes, the first priority is given to the Category 3 as an initiator of crop diversification. While, three schemes are grouped into the Category 7 due to no possibility introducing other crops.

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Tables & Figures

Table 1 Priority Order of Selected Crops for Each Scheme

State : Pulau Pinang

Code No.	Scheme	Annual Crops	Perennial Crops
PP001	Pinang Tunggal	SP, VG*	CN, SC, PL*
PP002	Sg. Jarak	SP, VG*	CN, SC, PL*
PP003	Tasek Gelugor	SP, VG*	CN, SC, PL*
PP004	Jarak Tengah	VG, SP	CN, SC, PL*
PP005	Kuala Tasek	VG, SP	CN, SC, PL*
PP006	Sg. Kulim	SP, VG*	CN, OP, SC, DM*, PL*
PP007	Sg. Kulim	SP, VG*	CN, OP, SC, DM*, PL*
PP008	Sg. Renjau	VG, SP	CN, SC, PL*
PP009	Juru	VG, SP	CN, SC, PL*
PP010	Machang Bubok	VG, SP	CN, SC, PL*
PP011	Tasek Junjung	VG, SP	CN, SC, PL*
PP012	Alma	SP	
PP017	Fasa I & IIA/IIB, Sg. Burong	SP	FC*
PP018	Padang Kumunting	SP	FC*

Remarks: Priority order is shown from left to right for each crop group.

- *; Needs for regional marketing promotion
- DP; Double cropping of paddy
- SP; Single cropping of paddy
- VG; Vegetables
- CN; Cashewnut
- PL; Pineapple
- OP; Oil palm
- SC; Sugarcane
- FC; Freshwater fishe pond

Table 2 Crop Diversification Potential for Each Scheme

State : P.Pinang

Code	Scheme	Category							
		1	2	3	4	5	6	7	8
PP001	Pinang Tunggal	*4	*2	*1	.	.	.	.	.
PP002	Sg. Jarak	*4	*2	*1	.	.	.	.	.
PP003	Tasek Gelugor	*4	*2	*1	.	.	.	.	.
PP004	Jarak Tengah	*1	*2	*2	.	.	.	*3	.
PP005	Kuala Tasek	*1	*2	*2	.	.	.	*3	.
PP006	Sg. Kulim	*4	*2	*1	.	.	.	.	.
PP007	Sg. Kulim	*4	*2	*1	.	.	.	.	.
PP008	Sg. Renjau	*1	*2	*2	.	.	.	*3	.
PP009	Juru	*1	*2	*2	.	.	.	*3	.
PP010	Machang Bubok	*1	*2	*2	.	.	.	*3	.
PP011	Tasek Junjung	*1	*2	*2	.	.	.	*3	.
PP012	Alma	.	.	.	.	.	.	*1	.
PP017	Fasa I & IIA/IIB, Sg. Burong	.	.	.	.	.	.	*1	.
PP018	Padang Kumunting	.	.	.	.	.	.	*1	.
*1	Super category	6	.	5	.	.	.	3	.
*2	2nd priority category	.	11	6	.	.	.	.	.
*3	3rd priority category	.	.	.	.	.	.	6	.
*4	4th priority category with needs of regional marketing promotion	5	.	.	.	.	.	.	.

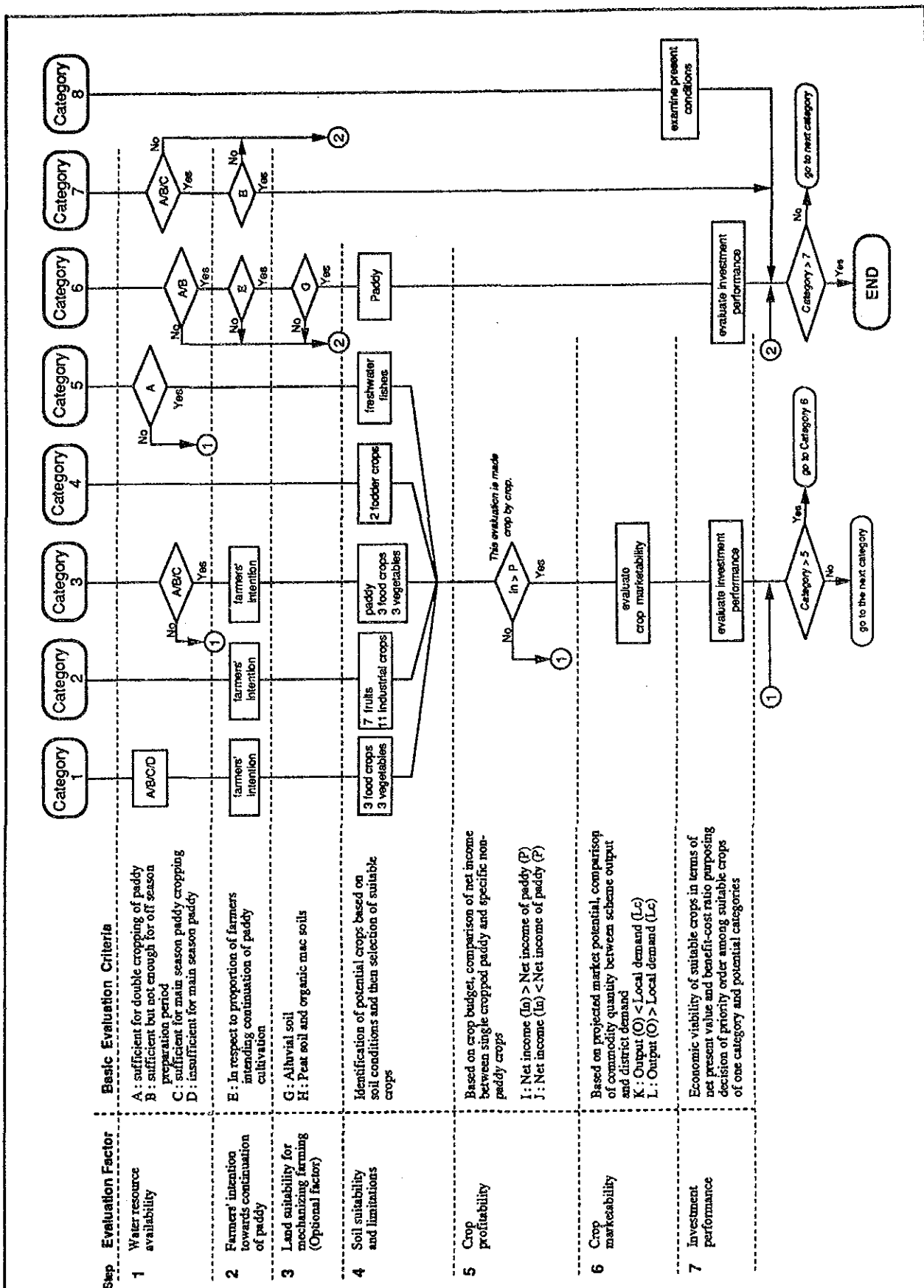


Fig. 1
Criteria and Procedure of Evaluation
for Crop Diversification Potential

FEASIBILITY STUDY ON RATIONALIZATION AND
 CROP DIVERSIFICATION IN NON-GRANARY
 IRRIGATED AREAS IN MALAYSIA

Japan International Cooperation Agency

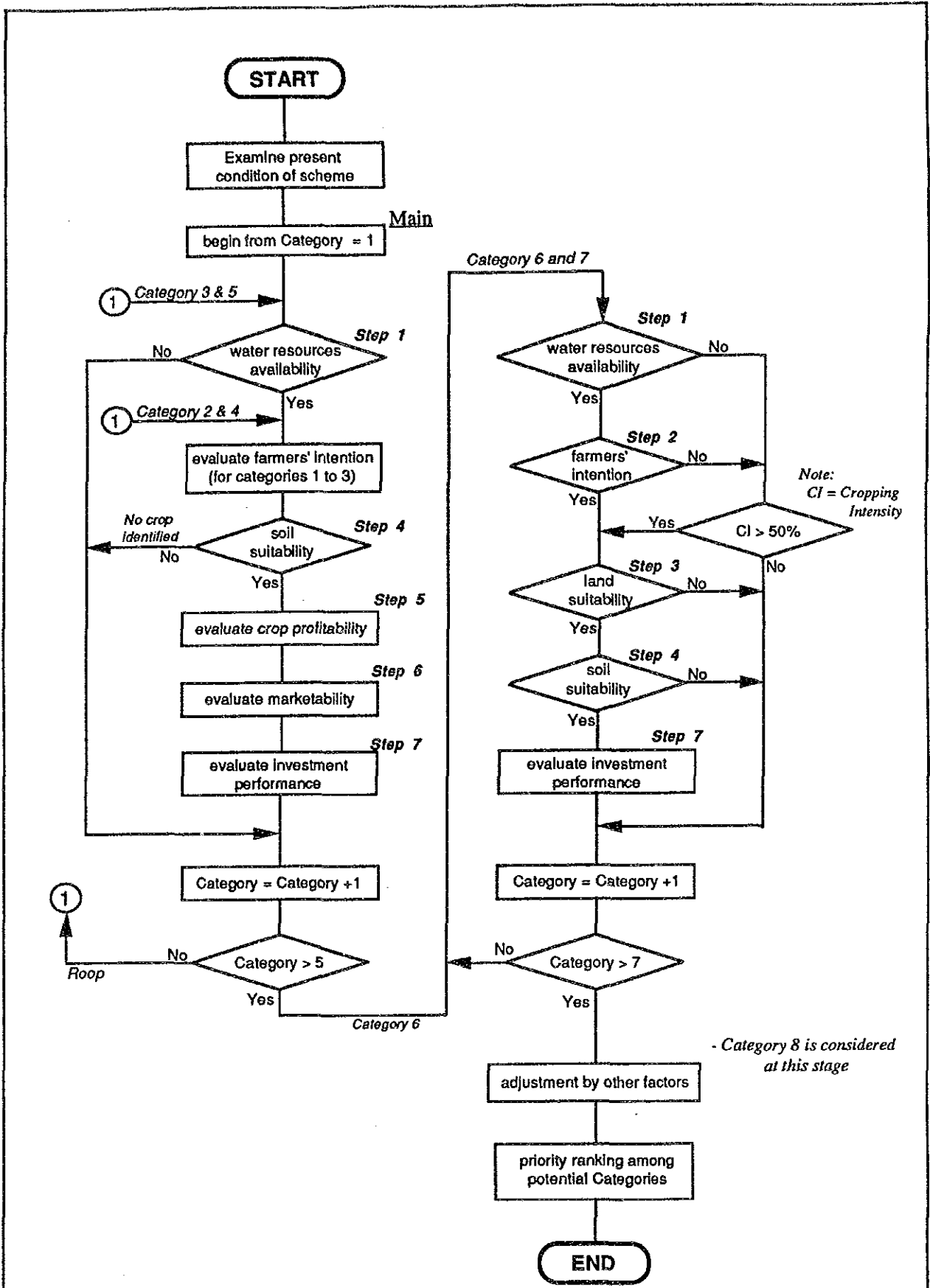


Fig. 2
General Flow of Evaluation
for Crop Diversification Potential

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in Non-granary Irrigated Areas in Malaysia*

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Appendix

Results of Evaluation for Crop Diversification Potential

Remarks

Category

Category 1	<i>Schemes to be converted to high value crop cultivation under irrigated condition</i>
Category 2	<i>Schemes to be converted to tree crop cultivation</i>
Category 3	<i>Schemes to introduce two-cropping system planting paddy during the main season and short-term annual crops during the off-season</i>
Category 4	<i>Schemes to be converted to animal feeding crop cultivation or cattle raising fields</i>
Category 5	<i>Schemes to be converted to freshwater fish culture ponds</i>
Category 6	<i>Schemes to be positively maintained as mini-granary areas</i>
Category 7	<i>Schemes to be maintained as paddy cultivation areas within a definite period of time for social welfare purposes and thereafter to be further categorized</i>
Category 8	<i>Schemes to be converted to housing/industrial and other uses</i>

Evaluation Item in Each Step

Step 1	<i>Available irrigation water quantity</i>
Step 2	<i>Farmers' intention towards paddy cultivation</i>
Step 3	<i>Land suitability for mechanized farming practices</i>
Step 4	<i>Soil suitability and limitations to diversify crops</i>
Step 5	<i>Crop profitability</i>
Step 6	<i>Crop marketability</i>
Step 7	<i>Investment performance</i>

- Note:
- If any item is examined, steps for the respective categories are indicated with a star mark "*".*
 - In step 7, BIC ratio at the interest rate of 10% is described.*

Evaluation Results of Each Scheme

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	<u>Page</u>
PP001 Pinang Tunggal	1
PP002 Sg. Jarak	2
PP003 Tasek Gelugor	3
PP004 Jarak Tengah	4
PP005 Kuala Tasek	5
PP006 Sg. Kulim	6
PP007 Sg. Kulim	7
PP008 Sg. Renjau	8
PP009 Juru	9
PP010 Machang Bubok	10
PP011 Tasek Junjung	11
PP012 Alma	12
PP017 Fasa I & IIA/IIB,Sg. Burong	13
PP018 Padang Kemunting	14

Crop Diversification Potential for PP001

Code Number : PP001 Name of Scheme : Pinang Tunggal
 State : P.Pinang District : S.P.Utara
 Type of Scheme : Pump
 Water source : Sufficient for double cropping
 Soil series : 2dt

Irrigable area (ha) Main : 710 Off : 710
 Trafficability of farm machinery : Good
 Paddy planting for last 3 years : More than 50% of irrigable area

Category	Step 1	Step 2	Step 3		Step 4	Step 5	Step 6	Step 7 (B/C)	Production (ton)
1	*	*	*	Ginger	B	A	-	2.5	10,650
				Groundnut	A	A	A	0.9	1,853
				Vegetable	A	A	-	13.8	12,567
2	*	*	*	Durian/Mango	C	A	-	11.0	4,828
				Guava	C	A	-	3.1	17,040
				Banana	C	A	-	0.7	7,455
				<u>Cashewnut</u>	<u>A</u>	<u>A</u>	<u>A</u>	<u>8.7</u>	<u>1,250</u>
				Papaya	B	A	-	0.6	17,750
				Citrus	B	A	-	2.9	7,455
				Pineapple	A	A	-	9.5	17,040
				Coconut	A	-	A		3,110
				Oilpalm	C	A	A	0.9	13,632
				Cocoa	C	A	A	0.6	2,201
				Rubber	B	A	A	0.6	973
				Sago	C	-	A		6,390
				Coffee	A	A	A	0.7	625
				<u>Tea</u>	<u>A</u>	<u>A</u>	<u>A</u>	<u>10.4</u>	<u>923</u>
				Clove	B	A	A	1.1	220
Tabacco	B	A	A	0.7	6,390				
<u>Sugarcane</u>	<u>A</u>	<u>A</u>	<u>A</u>	<u>3.3</u>	<u>14,200</u>				
<u>Pepper</u>	<u>A</u>	<u>A</u>	<u>A</u>	<u>16.4</u>	<u>2,095</u>				
3	*	*	*	Maize	A	-	-		2,308
				Sorghum	A	-	A		2,663
				Ginger	B	A	-	2.5	10,650
				Groundnut	A	A	A	0.9	1,853
				Vegetable	A	A	-	13.8	12,567
4	*	*	*	Fodder grasses	A	-	A		
				Pasture	A	-	A		
5	*	*	*			A	-	2.0	
6	*	*	*		<u>A</u>	<u>A</u>	<u>A</u>		
7	*	*	*		*	*	*		
8									

NOTE Underline : Crops with highest potential (Class A) in terms of crop suitability, profitability, marketability and invest performance (B/C > 1).
 * : Potential categories
 A : Suitable
 B : Marginal suitable due to lack of drainage facilities
 C : Marginal suitable due to limited factors other than drainage conditions
 - : Not suitable

Crop Diversification Potential for PP002

Code Number : PP002 Name of Scheme : Sg. Jarak
 State : P.Pinang District : S.P.Utara
 Type of Scheme : Gravity & Pump
 Water source : Sufficient for double cropping
 Soil series : 2dt

Irrigable area (ha) Main : 350 Off : 350
 Trafficability of farm machinery : Good
 Paddy planting for last 3 years : More than 50% of irrigable area

Category	Step 1	Step 2	Step 3		Step 4	Step 5	Step 6	Step 7 (B/C)	Production (ton)
1	*	*	*	Ginger	B	A	-	2.5	5,250
				Groundnut	A	A	A	0.9	914
				Vegetable	A	A	-	13.8	6,195
2	*	*	*	Durian/Mango	C	A	-	11.0	2,380
				Guava	C	A	-	3.1	8,400
				Banana	C	A	-	0.7	3,675
				<u>Cashewnut</u>	<u>A</u>	<u>A</u>	<u>A</u>	<u>8.7</u>	<u>616</u>
				Papaya	B	A	-	0.6	8,750
				Citrus	B	A	-	2.9	3,675
				Pineapple	A	A	-	9.5	8,400
				Coconut	A	-	A		1,533
				Oilpalm	C	A	A	0.9	6,720
				Cocoa	C	A	A	0.6	1,085
				Rubber	B	A	A	0.6	480
				Sago	C	-	A		3,150
				Coffee	A	A	A	0.7	308
				<u>Tea</u>	<u>A</u>	<u>A</u>	<u>A</u>	<u>10.4</u>	<u>455</u>
Clove	B	A	A	1.1	109				
Tabacco	B	A	A	0.7	3,150				
<u>Sugarcane</u>	<u>A</u>	<u>A</u>	<u>A</u>	<u>3.3</u>	<u>7,000</u>				
<u>Pepper</u>	<u>A</u>	<u>A</u>	<u>A</u>	<u>16.4</u>	<u>1,033</u>				
3	*	*	*	Maize	A	-	-		1,138
				Sorghum	A	-	A		1,313
				Ginger	B	A	-	2.5	5,250
				Groundnut	A	A	A	0.9	914
				Vegetable	A	A	-	13.8	6,195
4	*	*	*	Fodder grasses	A	-	A		
				Pasture	A	-	A		
5	*	*	*			A	-	2.0	
6	*	*	*		A	A	A		
7	*	*	*		*	*	*		
8									

NOTE Underline : Crops with highest potential (Class A) in terms of crop suitability, profitability, marketability and invest performance (B/C > 1).
 * : Potential categories
 A : Suitable
 B : Marginal suitable due to lack of drainage facilities
 C : Marginal suitable due to limited factors other than drainage conditions
 - : Not suitable

Crop Diversification Potential for PP003

Code Number : PP003 Name of Scheme : Tasek Gelugor
 State : P.Pinang District : S.P.Utara
 Type of Scheme : Pump
 Water source : Sufficient for double cropping
 Soil series : 2dt

Irrigable area (ha) Main : 221 Off : 221
 Trafficability of farm machinery : Good
 Paddy planting for last 3 years : More than 50% of irrigable area

Category	Step 1	Step 2	Step 3		Step 4	Step 5	Step 6	Step 7 (B/C)	Production (ton)
1	*	*	*	Ginger	B	A	-	2.5	3,315
				Groundnut	A	A	A	0.9	577
				Vegetable	A	A	-	13.8	3,912
2	*	*	*	Durian/Mango	C	A	-	11.0	1,503
				Guava	C	A	-	3.1	5,304
				Banana	C	A	-	0.7	2,321
				<u>Cashewnut</u>	<u>A</u>	<u>A</u>	<u>A</u>	<u>8.7</u>	<u>389</u>
				Papaya	B	A	-	0.6	5,525
				Citrus	B	A	-	2.9	2,321
				Pineapple	A	A	-	9.5	5,304
				Coconut	A	-	A		968
				Oilpalm	C	A	A	0.9	4,243
				Cocoa	C	A	A	0.6	685
				Rubber	B	A	A	0.6	303
				Sago	C	-	A		1,989
				Coffee	A	A	A	0.7	194
				<u>Tea</u>	<u>A</u>	<u>A</u>	<u>A</u>	<u>10.4</u>	<u>287</u>
				Clove	B	A	A	1.1	69
Tabacco	B	A	A	0.7	1,989				
<u>Sugarcane</u>	<u>A</u>	<u>A</u>	<u>A</u>	<u>3.3</u>	<u>4,420</u>				
<u>Pepper</u>	<u>A</u>	<u>A</u>	<u>A</u>	<u>16.4</u>	<u>652</u>				
3	*	*	*	Maize	A	-	-		718
				Sorghum	A	-	A		829
				Ginger	B	A	-	2.5	3,315
				Groundnut	A	A	A	0.9	577
				Vegetable	A	A	-	13.8	3,912
4	*	*	*	Fodder grasses	A	-	A		
				Pasture	A	-	A		
5	*	*	*			A	-	2.0	
6	*	*	*		A	A	A		
7	*	*	*		*	*	*		
8									

NOTE Underline : Crops with highest potential (Class A) in terms of crop suitability, profitability, marketability and invest performance (B/C > 1).
 * : Potential categories
 A : Suitable
 B : Marginal suitable due to lack of drainage facilities
 C : Marginal suitable due to limited factors other than drainage conditions
 - : Not suitable

Crop Diversification Potential for PP004

Code Number : PP004 Name of Scheme : Jarak Tengah
 State : P.Pinang District : S.P.Utara
 Type of Scheme : Pump
 Water source : Sufficient for double cropping
 Soil series : 2dt

Irrigable area (ha) Main : 105 Off : 105
 Trafficability of farm machinery : Good
 Paddy planting for last 3 years : Less than 50% of irrigable area

Category	Step 1	Step 2	Step 3		Step 4	Step 5	Step 6	Step 7 (B/C)	Production (ton)
1	*	*	*	Ginger	B	A	-	2.5	1,575
				Groundnut	A	A	A	0.9	274
				Vegetable	A	A	-	13.8	1,859
2	*	*	*	Durian/Mango	C	A	-	11.0	714
				Guava	C	A	-	3.1	2,520
				Banana	C	A	-	0.7	1,103
				<u>Cashewnut</u>	A	A	A	<u>8.7</u>	<u>185</u>
				Papaya	B	A	-	0.6	2,625
				Citrus	B	A	-	2.9	1,103
				Pineapple	A	A	-	9.5	2,520
				Coconut	A	-	A		460
				Oilpalm	C	A	A	0.9	2,016
				Cocoa	C	A	A	0.6	326
				Rubber	B	A	A	0.6	144
				Sago	C	-	A		945
				Coffee	A	A	A	0.7	92
				<u>Tea</u>	A	A	A	<u>10.4</u>	<u>137</u>
				Clove	B	A	A	1.1	33
Tabacco	B	A	A	0.7	945				
<u>Sugarcane</u>	A	A	A	<u>3.3</u>	<u>2,100</u>				
<u>Pepper</u>	A	A	A	<u>16.4</u>	<u>310</u>				
3	*	*	*	Maize	A	-	-		341
				Sorghum	A	-	A		394
				Ginger	B	A	-	2.5	1,575
				Groundnut	A	A	A	0.9	274
				Vegetable	A	A	-	13.8	1,859
4	*	*	*	Fodder grasses	A	-	A		
				Pasture	A	-	A		
5	*	*	*			A	-	2.0	
6	*								
7	*	*	*		*	*	*		
8									

NOTE Underline : Crops with highest potential (Class A) in terms of crop suitability, profitability, marketability and invest performance (B/C > 1).
 * : Potential categories
 A : Suitable
 B : Marginal suitable due to lack of drainage facilities
 C : Marginal suitable due to limited factors other than drainage conditions
 - : Not suitable

Crop Diversification Potential for PP005

Code Number : PP005 Name of Scheme : Kuala Tasek
 State : P.Pinang District : S.P.Tengah
 Type of Scheme : Pump
 Water source : Sufficient for double cropping
 Soil series : 2dt

Irrigable area (ha) Main : 18 Off : 18
 Trafficability of farm machinery : Good
 Paddy planting for last 3 years : Less than 50% of irrigable area

Category	Step 1	Step 2	Step 3		Step 4	Step 5	Step 6	Step 7 (B/C)	Production (ton)
1	*	*	*	Ginger	B	A	-	2.5	270
				Groundnut	A	A	A	0.9	47
				Vegetable	A	A	-	13.8	319
2	*	*	*	Durian/Mango	C	A	-	11.0	122
				Guava	C	A	-	3.1	432
				Banana	C	A	-	0.7	189
				<u>Cashewnut</u>	A	A	A	<u>8.7</u>	<u>32</u>
				Papaya	B	A	-	0.6	450
				Citrus	B	A	-	2.9	189
				Pineapple	A	A	-	9.5	432
				Coconut	A	-	A		79
				Oilpalm	C	A	A	0.9	346
				Cocoa	C	A	A	0.6	56
				Rubber	B	A	A	0.6	25
				Sago	C	-	A		162
				Coffee	A	A	A	0.7	16
				<u>Tea</u>	A	A	A	<u>10.4</u>	<u>23</u>
				Clove	B	A	A	1.1	6
Tabacco	B	A	A	0.7	162				
<u>Sugarcane</u>	A	A	A	<u>3.3</u>	<u>360</u>				
<u>Pepper</u>	A	A	A	<u>16.4</u>	<u>53</u>				
3	*	*	*	Maize	A	-	-		59
				Sorghum	A	-	A		68
				Ginger	B	A	-	2.5	270
				Groundnut	A	A	A	0.9	47
				Vegetable	A	A	-	13.8	319
4	*	*	*	Fodder grasses	A	-	A		
				Pasture	A	-	A		
5	*	*	*			A	-	2.0	
6	*								
7	*	*	*		*	*	*		
8									

NOTE Underline : Crops with highest potential (Class A) in terms of crop suitability, profitability, marketability and invest performance (B/C > 1).
 * : Potential categories
 A : Suitable
 B : Marginal suitable due to lack of drainage facilities
 C : Marginal suitable due to limited factors other than drainage conditions
 - : Not suitable

Crop Diversification Potential for PP006

Code Number : PP006 Name of Scheme : Sg. Kulim
 State : P.Pinang District : S.P.Tengah
 Type of Scheme : Gravity
 Water source : Sufficient for double cropping
 Soil series : 2d

Irrigable area (ha) Main : 561 Off : 561
 Trafficability of farm machinery : Good
 Paddy planting for last 3 years : More than 50% of irrigable area

Category	Step 1	Step 2	Step 3		Step 4	Step 5	Step 6	Step 7 (B/C)	Production (ton)
1	*	*	*	Groundnut	A	A	A	0.9	1,464
				Vegetable	A	A	-	13.8	9,930
2	*	*	*	Durian/Mango	A	A	-	43.6	3,815
				Guava	A	A	-	12.2	13,464
				Banana	A	A	-	2.7	5,891
				<u>Cashewnut</u>	A	A	A	<u>8.7</u>	<u>987</u>
				Citrus	B	A	-	2.9	5,891
				Pineapple	A	A	-	9.5	13,464
				Coconut	A	-	A		2,457
				<u>Oilpalm</u>	A	A	A	<u>3.6</u>	<u>10,771</u>
				<u>Cocoa</u>	A	A	A	<u>2.2</u>	<u>1,739</u>
				Rubber	B	A	A	0.6	769
				Coffee	B	A	A	0.4	494
				<u>Tea</u>	A	A	A	<u>10.4</u>	<u>729</u>
				Clove	B	A	A	1.1	174
				Tabacco	B	A	A	0.7	5,049
<u>Sugarcane</u>	A	A	A	<u>3.3</u>	<u>11,220</u>				
<u>Pepper</u>	A	A	A	<u>16.4</u>	<u>1,655</u>				
3	*	*	*	Maize	A	-	-		1,823
				Sorghum	A	-	A		2,104
				Groundnut	A	A	A	0.9	1,464
				Vegetable	A	A	-	13.8	9,930
4	*	*	*	Fodder grasses	A	-	A		
				Pasture	A	-	A		
5	*	*	*			A	-	2.0	
6	*	*	*		A	A	A		
7	*	*	*		*	*	*		
8									

NOTE Underline : Crops with highest potential (Class A) in terms of crop suitability, profitability, marketability and invest performance (B/C > 1).

- * : Potential categories
- A : Suitable
- B : Marginal suitable due to lack of drainage facilities
- C : Marginal suitable due to limited factors other than drainage conditions
- : Not suitable

Crop Diversification Potential for PP007

Code Number : PP007 Name of Scheme : Sg. Kulim
 State : P.Pinang District : S.P.Tengah
 Type of Scheme : Gravity & Pump
 Water source : Sufficient for double cropping
 Soil series : 2d

Irrigable area (ha) Main : 784 Off : 784
 Trafficability of farm machinery : Good
 Paddy planting for last 3 years : More than 50% of irrigable area

Category	Step 1	Step 2	Step 3		Step 4	Step 5	Step 6	Step 7 (B/C)	Production (ton)
1	*	*	*	Groundnut	A	A	A	0.9	2,046
				Vegetable	A	A	-	13.8	13,877
2	*	*	*	Durian/Mango	A	A	-	43.6	5,331
				Guava	A	A	-	12.2	18,816
				Banana	A	A	-	2.7	8,232
				<u>Cashewnut</u>	A	A	A	<u>8.7</u>	<u>1,380</u>
				Citrus	B	A	-	2.9	8,232
				Pineapple	A	A	-	9.5	18,816
				Coconut	A	-	A		3,434
				<u>Oilpalm</u>	A	A	A	<u>3.6</u>	<u>15,053</u>
				<u>Cocoa</u>	A	A	A	<u>2.2</u>	<u>2,430</u>
				Rubber	B	A	A	0.6	1,074
				Coffee	B	A	A	0.4	690
				<u>Tea</u>	A	A	A	<u>10.4</u>	<u>1,019</u>
				Clove	B	A	A	1.1	243
				Tabacco	B	A	A	0.7	7,056
<u>Sugarcane</u>	A	A	A	<u>3.3</u>	<u>15,680</u>				
<u>Pepper</u>	A	A	A	<u>16.4</u>	<u>2,313</u>				
3	*	*	*	Maize	A	-	-		2,548
				Sorghum	A	-	A		2,940
				Groundnut	A	A	A	0.9	2,046
				Vegetable	A	A	-	13.8	13,877
4	*	*	*	Fodder grasses	A	-	A		
				Pasture	A	-	A		
5	*	*	*			A	-	2.0	
6	*	*	*		A	A	A		
7	*	*	*		*	*	*		
8									

NOTE Underline : Crops with highest potential (Class A) in terms of crop suitability, profitability, marketability and invest performance (B/C > 1).
 * : Potential categories
 A : Suitable
 B : Marginal suitable due to lack of drainage facilities
 C : Marginal suitable due to limited factors other than drainage conditions
 - : Not suitable

Crop Diversification Potential for PP008

Code Number : PP008 Name of Scheme : Sg. Renjau
 State : P.Pinang District : S.P.Tengah
 Type of Scheme : Gravity
 Water source : Sufficient for 'double cropping'
 Soil series : 2dt

Irrigable area (ha) Main : 20 Off : 20
 Trafficability of farm machinery : Good
 Paddy planting for last 3 years : More than 50% of irrigable area

Category	Step 1	Step 2	Step 3		Step 4	Step 5	Step 6	Step 7 (B/C)	Production (ton)
1	*	*	*	Ginger	B	A	-	2.5	300
				Groundnut	A	A	A	0.9	52
				Vegetable	A	A	-	13.8	354
2	*	*	*	Durian/Mango	C	A	-	11.0	136
				Guava	C	A	-	3.1	480
				Banana	C	A	-	0.7	210
				<u>Cashewnut</u>	A	A	A	<u>8.7</u>	<u>35</u>
				Papaya	B	A	-	0.6	500
				Citrus	B	A	-	2.9	210
				Pineapple	A	A	-	9.5	480
				Coconut	A	-	A		88
				Oilpalm	C	A	A	0.9	384
				Cocoa	C	A	A	0.6	62
				Rubber	B	A	A	0.6	27
				Sago	C	-	A		180
				Coffee	A	A	A	0.7	18
				<u>Tea</u>	A	A	A	<u>10.4</u>	<u>25</u>
Clove	B	A	A	1.1	6				
Tabacco	B	A	A	0.7	180				
<u>Sugarcane</u>	A	A	A	<u>3.3</u>	<u>400</u>				
<u>Pepper</u>	A	A	A	<u>16.4</u>	<u>59</u>				
3	*	*	*	Maize	A	-	-		65
				Sorghum	A	-	A		75
				Ginger	B	A	-	2.5	300
				Groundnut	A	A	A	0.9	52
				Vegetable	A	A	-	13.8	354
4	*	*	*	Fodder grasses	A	-	A		
				Pasture	A	-	A		
5	*	*	*			A	-	2.0	
6	*	*	*		A	A	A		
7	*	*	*		*	*	*		
8									

NOTE Underline : Crops with highest potential (Class A) in terms of crop suitability, profitability, marketability and invest performance (B/C > 1).
 * : Potential categories
 A : Suitable
 B : Marginal suitable due to lack of drainage facilities
 C : Marginal suitable due to limited factors other than drainage conditions
 - : Not suitable

Crop Diversification Potential for PP009

Code Number : PP009 Name of Scheme : Juru
 State : P.Pinang District : S.P.Tengah
 Type of Scheme : Pump
 Water source : Sufficient for double cropping
 Soil series : 2dt

Irrigable area (ha) Main : 60 Off : 60
 Trafficability of farm machinery : Good
 Paddy planting for last 3 years : Less than 50% of irrigable area

Category	Step 1	Step 2	Step 3		Step 4	Step 5	Step 6	Step 7 (B/C)	Production (ton)
1	*	*	*	Ginger	B	A	-	2.5	900
				Groundnut	A	A	A	0.9	157
				Vegetable	A	A	-	13.8	1,062
2	*	*	*	Durian/Mango	C	A	-	11.0	408
				Guava	C	A	-	3.1	1,440
				Banana	C	A	-	0.7	630
				<u>Cashewnut</u>	A	A	A	<u>8.7</u>	<u>106</u>
				Papaya	B	A	-	0.6	1,500
				Citrus	B	A	-	2.9	630
				Pineapple	A	A	-	9.5	1,440
				Coconut	A	-	A		263
				Oilpalm	C	A	A	0.9	1,152
				Cocoa	C	A	A	0.6	186
				Rubber	B	A	A	0.6	82
				Sago	C	-	A		540
				Coffee	A	A	A	0.7	53
				<u>Tea</u>	A	A	A	<u>10.4</u>	<u>78</u>
Clove	B	A	A	1.1	19				
Tabacco	B	A	A	0.7	540				
<u>Sugarcane</u>	A	A	A	<u>3.3</u>	<u>1,200</u>				
<u>Pepper</u>	A	A	A	<u>16.4</u>	<u>177</u>				
3	*	*	*	Maize	A	-	-		195
				Sorghum	A	-	A		225
				Ginger	B	A	-	2.5	900
				Groundnut	A	A	A	0.9	157
				Vegetable	A	A	-	13.8	1,062
4	*	*	*	Fodder grasses	A	-	A		
				Pasture	A	-	A		
5	*	*	*			A	-	2.0	
6	*								
7	*	*	*		*	*	*		
8									

NOTE Underline : Crops with highest potential (Class A) in terms of crop suitability, profitability, marketability and invest performance (B/C > 1).
 * : Potential categories
 A : Suitable
 B : Marginal suitable due to lack of drainage facilities
 C : Marginal suitable due to limited factors other than drainage conditions
 - : Not suitable

Crop Diversification Potential for PP010

Code Number : PP010 Name of Scheme : Machang Bubok
 State : P.Pinang District : S.P.Tengah
 Type of Scheme : Gravity
 Water source : Limited to single cropping
 Soil series : 2dt

Irrigable area (ha) Main : 111 Off : 111
 Trafficability of farm machinery : Good
 Paddy planting for last 3 years : Less than 50% of irrigable area

Category	Step 1	Step 2	Step 3		Step 4	Step 5	Step 6	Step 7 (B/C)	Production (ton)
1	*	*	*	Ginger	B	A	-	2.5	1,665
				Groundnut	A	A	A	0.9	290
				Vegetable	A	A	-	13.8	1,965
2	*	*	*	Durian/Mango	C	A	-	11.0	755
				Guava	C	A	-	3.1	2,664
				Banana	C	A	-	0.7	1,166
				<u>Cashewnut</u>	A	A	A	<u>8.7</u>	<u>195</u>
				Papaya	B	A	-	0.6	2,775
				Citrus	B	A	-	2.9	1,166
				Pineapple	A	A	-	9.5	2,664
				Coconut	A	-	A		486
				Oilpalm	C	A	A	0.9	2,131
				Cocoa	C	A	A	0.6	344
				Rubber	B	A	A	0.6	152
				Sago	C	-	A		999
				Coffee	A	A	A	0.7	98
				Tea	A	A	A	<u>10.4</u>	<u>144</u>
Clove	B	A	A	1.1	34				
Tabacco	B	A	A	0.7	999				
<u>Sugarcane</u>	A	A	A	<u>3.3</u>	<u>2,220</u>				
<u>Pepper</u>	A	A	A	<u>16.4</u>	<u>327</u>				
3	*	*	*	Maize	A	-	-		361
				Sorghum	A	-	A		416
				Ginger	B	A	-	2.5	1,665
				Groundnut	A	A	A	0.9	290
				Vegetable	A	A	-	13.8	1,965
4	*	*	*	Fodder grasses	A	-	A		
				Pasture	A	-	A		
5									
6									
7	*	*	*		*	*	*		
8									

NOTE Underline : Crops with highest potential (Class A) in terms of crop suitability, profitability, marketability and invest performance (B/C > 1).
 * : Potential categories
 A : Suitable
 B : Marginal suitable due to lack of drainage facilities
 C : Marginal suitable due to limited factors other than drainage conditions
 - : Not suitable

Crop Diversification Potential for PP011

Code Number : PP011 Name of Scheme : Tasek Junjung
 State : P.Pinang District : S.P.Selatan
 Type of Scheme : Gravity
 Water source : Sufficient for double cropping
 Soil series : 2dt

Irrigable area (ha) Main : 182 Off : 182
 Trafficability of farm machinery : Good
 Paddy planting for last 3 years : More than 50% of irrigable area

Category	Step 1	Step 2	Step 3		Step 4	Step 5	Step 6	Step 7 (B/C)	Production (ton)
1	*	*	*	Ginger	B	A	-	2.5	2,730
				Groundnut	A	A	A	0.9	475
				Vegetable	A	A	-	13.8	3,221
2	*	*	*	Durian/Mango	C	A	-	11.0	1,238
				Guava	C	A	-	3.1	4,368
				Banana	C	A	-	0.7	1,911
				<u>Cashewnut</u>	<u>A</u>	<u>A</u>	<u>A</u>	<u>8.7</u>	<u>320</u>
				Papaya	B	A	-	0.6	4,550
				Citrus	B	A	-	2.9	1,911
				Pineapple	A	A	-	9.5	4,368
				Coconut	A	-	A		797
				Oilpalm	C	A	A	0.9	3,494
				Cocoa	C	A	A	0.6	564
				Rubber	B	A	A	0.6	249
				Sago	C	-	A		1,638
				Coffee	A	A	A	0.7	160
				<u>Tea</u>	<u>A</u>	<u>A</u>	<u>A</u>	<u>10.4</u>	<u>237</u>
Clove	B	A	A	1.1	56				
Tabacco	B	A	A	0.7	1,638				
<u>Sugarcane</u>	<u>A</u>	<u>A</u>	<u>A</u>	<u>3.3</u>	<u>3,640</u>				
<u>Pepper</u>	<u>A</u>	<u>A</u>	<u>A</u>	<u>16.4</u>	<u>537</u>				
3	*	*	*	Maize	A	-	-		592
				Sorghum	A	-	A		683
				Ginger	B	A	-	2.5	2,730
				Groundnut	A	A	A	0.9	475
				Vegetable	A	A	-	13.8	3,221
4	*	*	*	Fodder grasses	A	-	A		
				Pasture	A	-	A		
5	*	*	*			A	-	2.0	
6	*	*	*		<u>A</u>	<u>A</u>	<u>A</u>		
7	*	*	*		*	*	*		
8									

NOTE Underline : Crops with highest potential (Class A) in terms of crop suitability, profitability, marketability and invest performance (B/C > 1).

- * : Potential categories
- A : Suitable
- B : Marginal suitable due to lack of drainage facilities
- C : Marginal suitable due to limited factors other than drainage conditions
- : Not suitable

Crop Diversification Potential for PP012

Code Number : PP012 Name of Scheme : Alma
 State : P.Pinang District : S.P.Tengah
 Type of Scheme : Controlled drainage
 Water source : Insufficient for main season paddy
 Soil series :

Irrigable area (ha) Main : 22 Off : 22
 Trafficability of farm machinery : Good
 Paddy planting for last 3 years : More than 50% of irrigable area

Category	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7	Production (B/C)	Production (ton)
5									
6									
7	*	*	*	*	*	*	*		
8									

NOTE Underline : Crops with highest potential (Class A) in terms of crop suitability, profitability, marketability and invest performance (B/C > 1).
 * : Potential categories
 A : Suitable
 B : Marginal suitable due to lack of drainage facilities
 C : Marginal suitable due to limited factors other than drainage conditions
 - : Not suitable

Crop Diversification Potential for PP017

Code Number : PP017 Name of Scheme : Fasa I & IIA/IIB, Sq. Burong
 State : P.Pinang District : Barat Daya
 Type of Scheme : Inundation
 Soil series :

Irrigable area (ha) Main : 150 Off : 134
 Trafficability of farm machinery : Good
 Paddy planting for last 3 years : More than 50% of irrigable area

Category	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7 (B/C)	Production (ton)
5	*	*	*		A	-	2.0	
6	*	*	*					
7	*	*	*	*	*	*		
8								

NOTE Underline : Crops with highest potential (Class A) in terms of crop suitability, profitability, marketability and invest performance (B/C > 1).
 * : Potential categories
 A : Suitable
 B : Marginal suitable due to lack of drainage facilities
 C : Marginal suitable due to limited factors other than drainage conditions
 - : Not suitable

Crop Diversification Potential for PP018

Code Number : PP018 Name of Scheme : Padang Kemunting
 State : P.Pinang District : Barat Daya
 Type of Scheme : Gravity
 Soil series :

Irrigable area (ha) Main : 247 Off : 247
 Trafficability of farm machinery : Good
 Paddy planting for last 3 years : Less than 50% of irrigable area

Category	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7	Production (B/C)	Production (ton)
5	*	*	*		A	-		2.0	
6	*								
7	*	*	*	*	*	*			
8									

NOTE Underline : Crops with highest potential (Class A) in terms of crop suitability, profitability, marketability and invest performance (B/C > 1).
 * : Potential categories
 A : Suitable
 B : Marginal suitable due to lack of drainage facilities
 C : Marginal suitable due to limited factors other than drainage conditions
 - : Not suitable

100°

100°30'

101°

Feasibility Study on Rationalization and Crop Di
in Non-granary Irrigated Areas in Malay

List of Scheme

Code	Name	Irrigable area (ha)	
		Main season	Off season
E, D			
PP018	Padang Kumunting	247	247
H, I, J, E			
PP017	Fasa I & IIA/IIB, Sg. Burong	150	134
North			
PP001	Pinang Tunggal	710	710
PP002	Sg. Jarak	350	350
PP003	Tasek Gelugor	221	221
PP004	Jarak Tengah	105	105
Sebrg. Peral Selatan			
PP011	Tasek Junjung	182	182
PP005	Kuala Tasek	18	18
PP006	Sg. Kulim	561	561
PP007	Sg. Kulim	784	784
PP008	Sg. Renjau	20	20
PP009	Juru	60	60
PP010	Machang Bubok	111	111
PP012	Alma	22	22

Location of Non-granary Irriga
P. Pinan

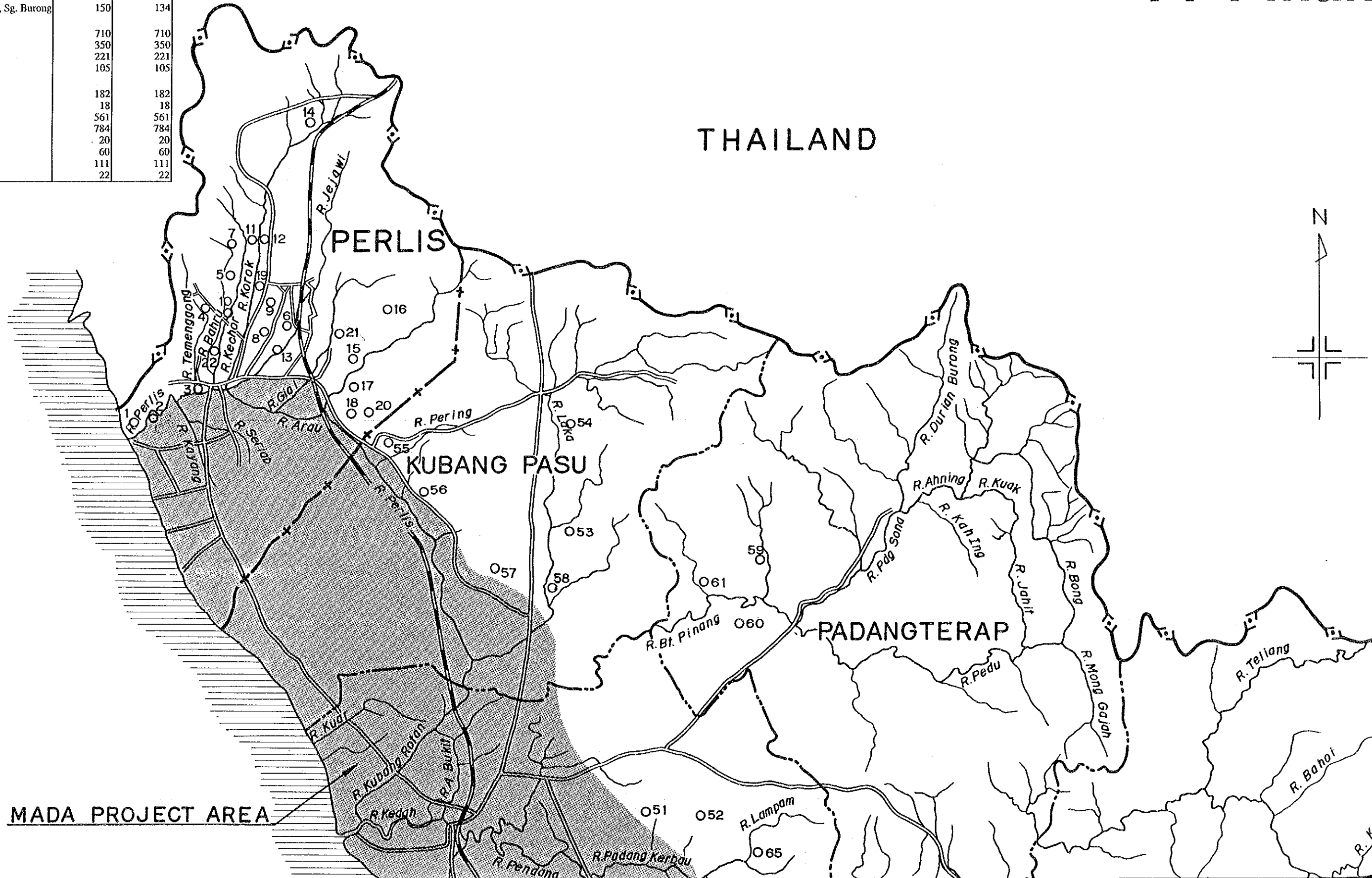
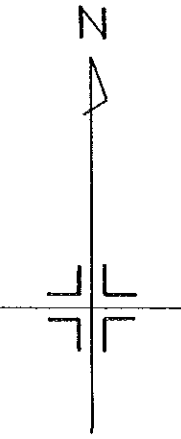
THAILAND

PERLIS

KUBANG PASU

PADANGTERAP

MADA PROJECT AREA



100°30'

101°

Feasibility Study on Rationalization and Crop Diversification
in Non-granary Irrigated Areas in Malaysia

Location of Non-granary Irrigation Scheme P. Pinang

Scheme

Irrigable area (ha)	
Main season	Off season
247	247
150	134
710	710
350	350
221	221
105	105
182	182
18	18
561	561
784	784
20	20
60	60
111	111
22	22

THAILAND

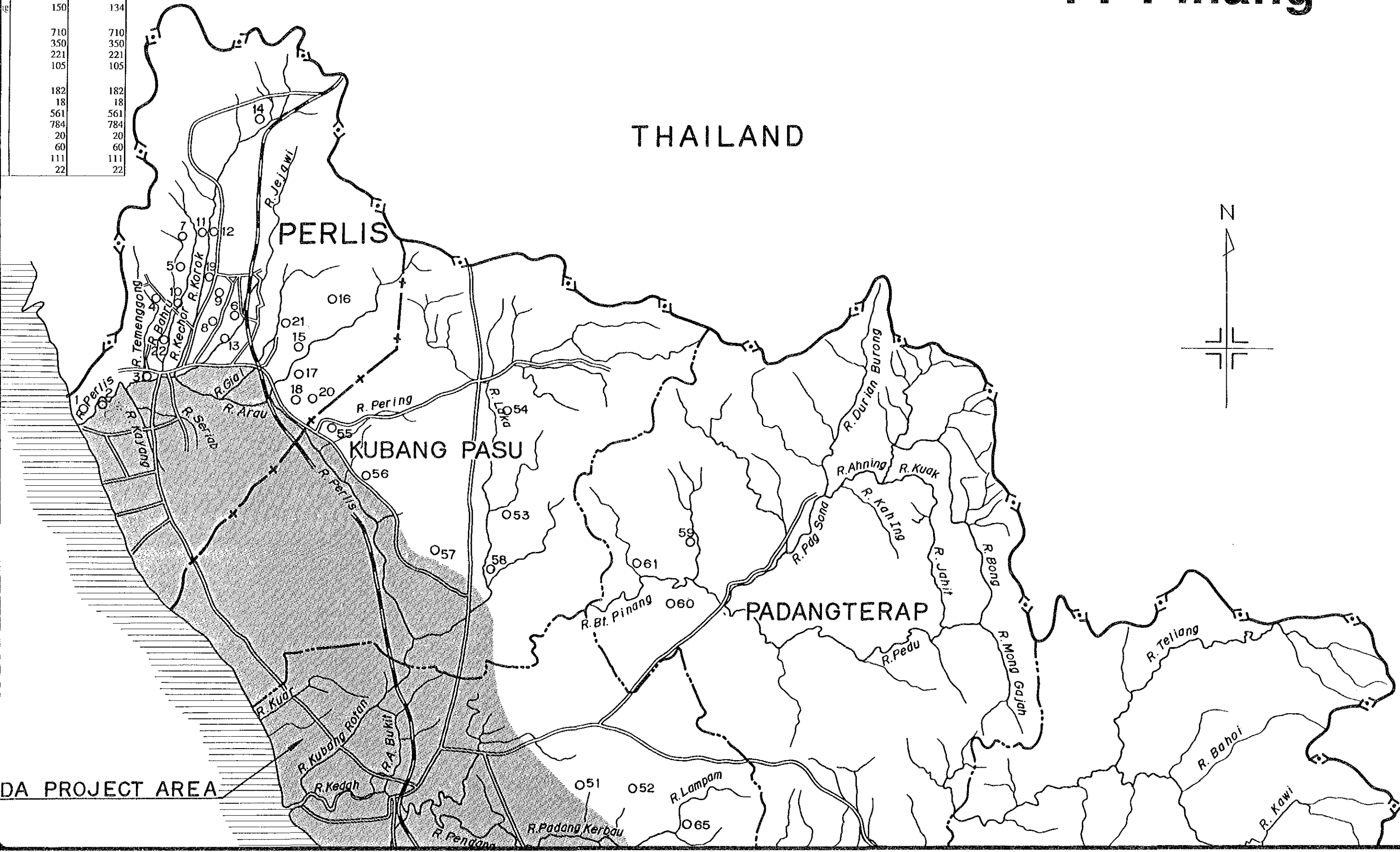
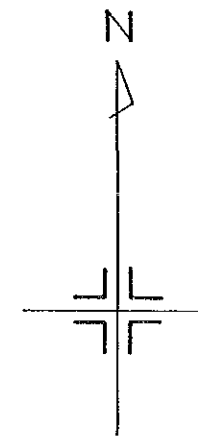
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KUBANG PASU

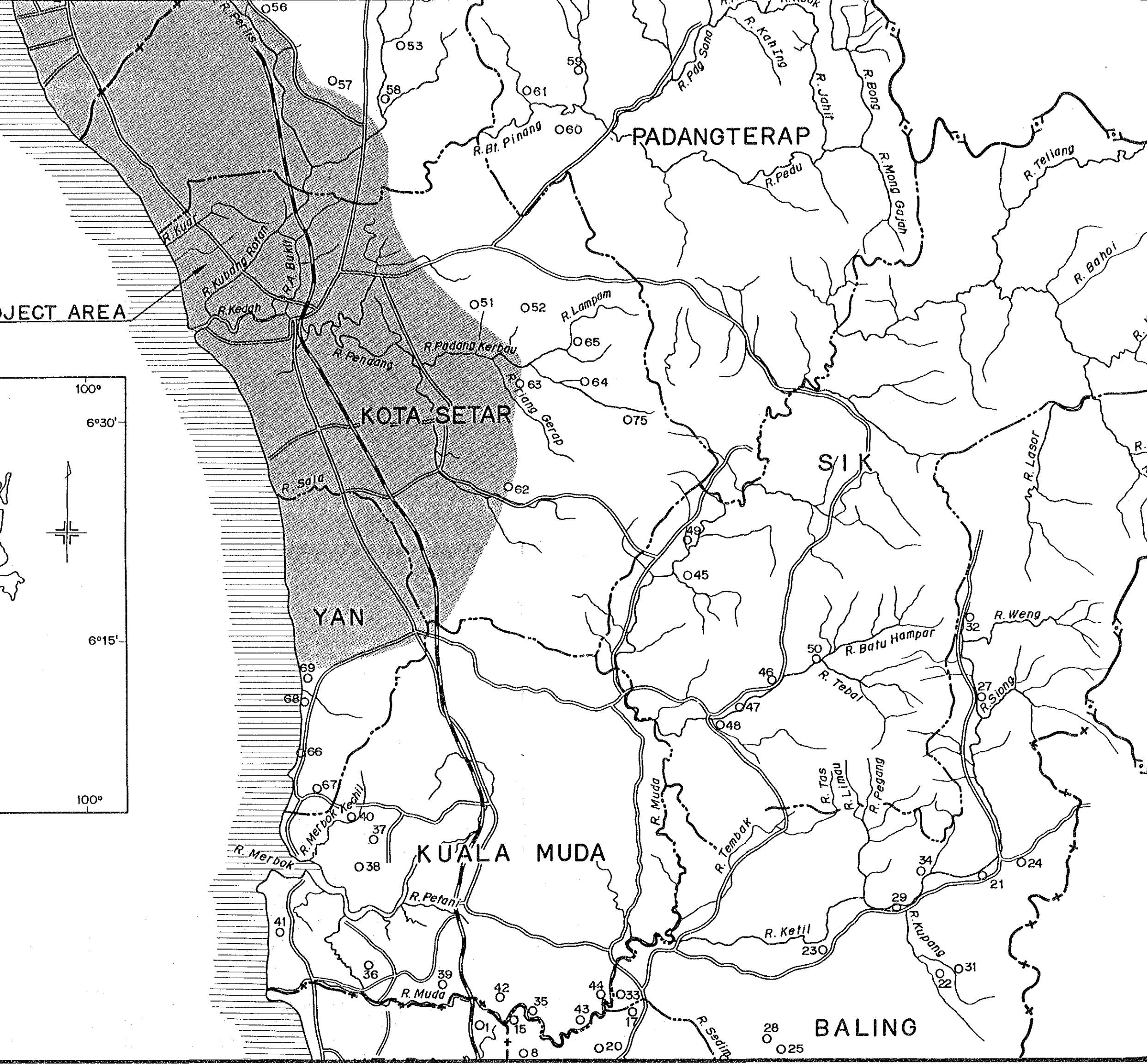
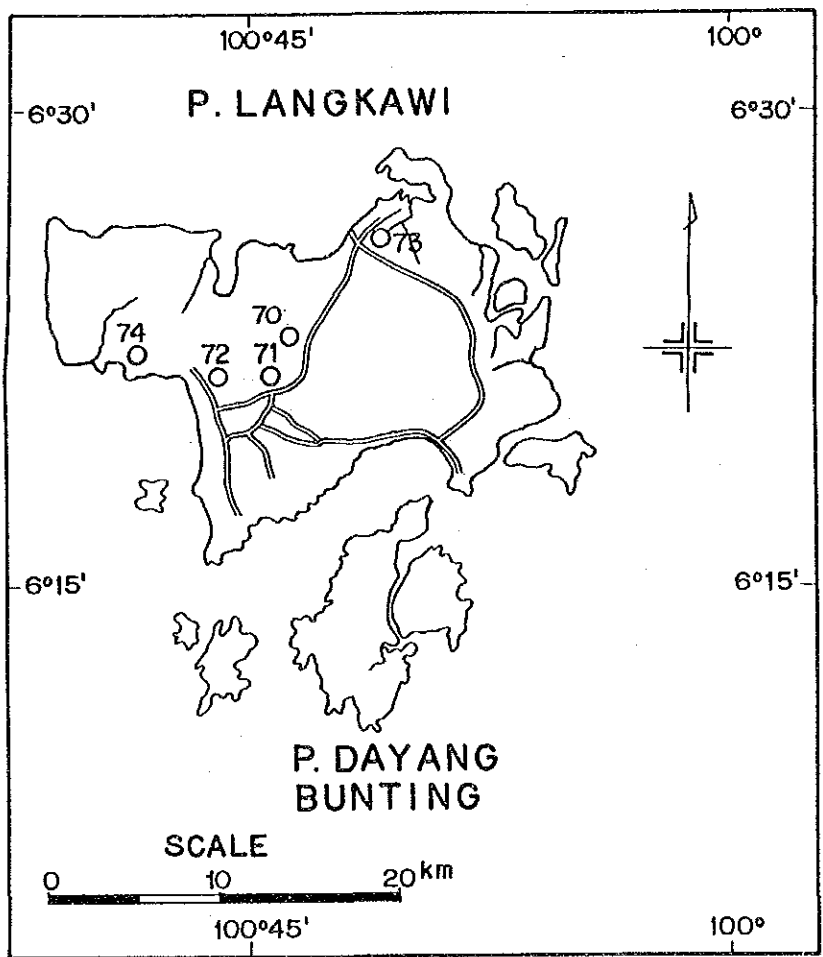
PADANGTERAP

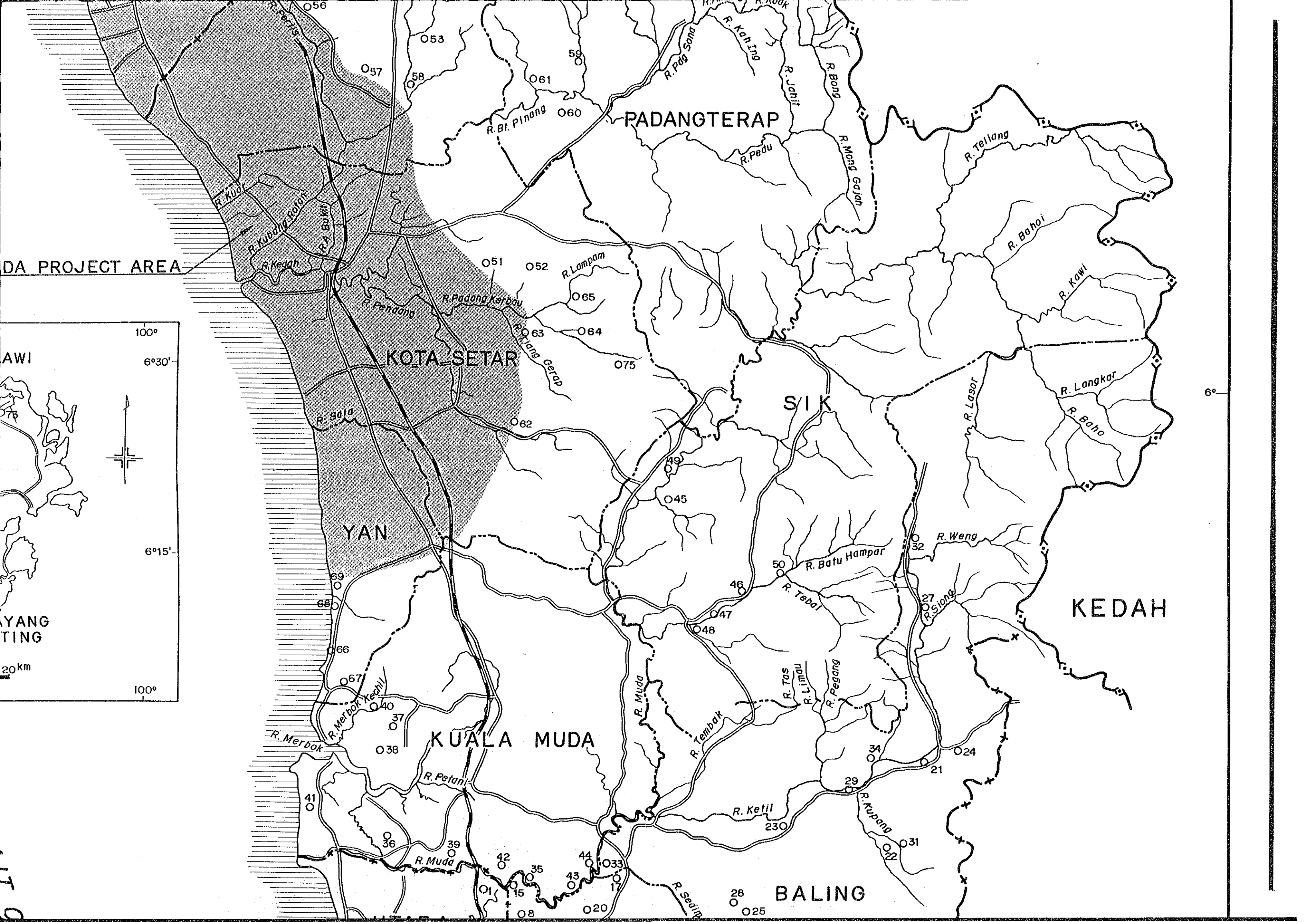
DA PROJECT AREA

6°30'



MADA PROJECT AREA





PROJECT AREA

AWI

YANG
TING

20km

IT

PADANGTERAP

KOTA SETAR

YAN

KUALA MUDA

SIK

KEDAH

BALING

100°
6°30'
6°15'
100°

6°

R. Perlis
R. Kubang
R. Kubang Rotan
R. Bukit
R. Kedah

R. Bt. Pinang

R. Lampam

R. Padang Kerbau

R. Padang Gerap

R. Langkat

R. Sela

R. Merbok

R. Merbok

R. Petani

R. Muda

R. Muda

R. Tembak

R. Tas

R. Limau

R. Pegang

R. Ketil

R. Sedir

R. Batu Hampar

R. Tebal

R. Weng

R. Siong

R. Lasor

R. Bahoi

R. Kawi

R. Langkat

R. Bahoi

R. Kubang

O53

O57

O58

O61

O60

O51

O52

O65

O64

O75

O45

50

46

O47

O48

O32

O69

O68

O66

O67

O40

O37

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O15

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O43

O33

O17

O20

O28

O25

O34

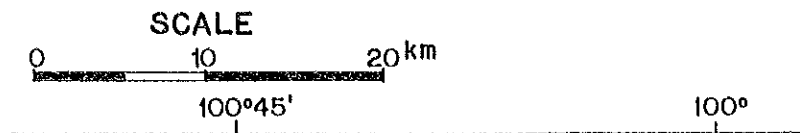
O24

O29

O21

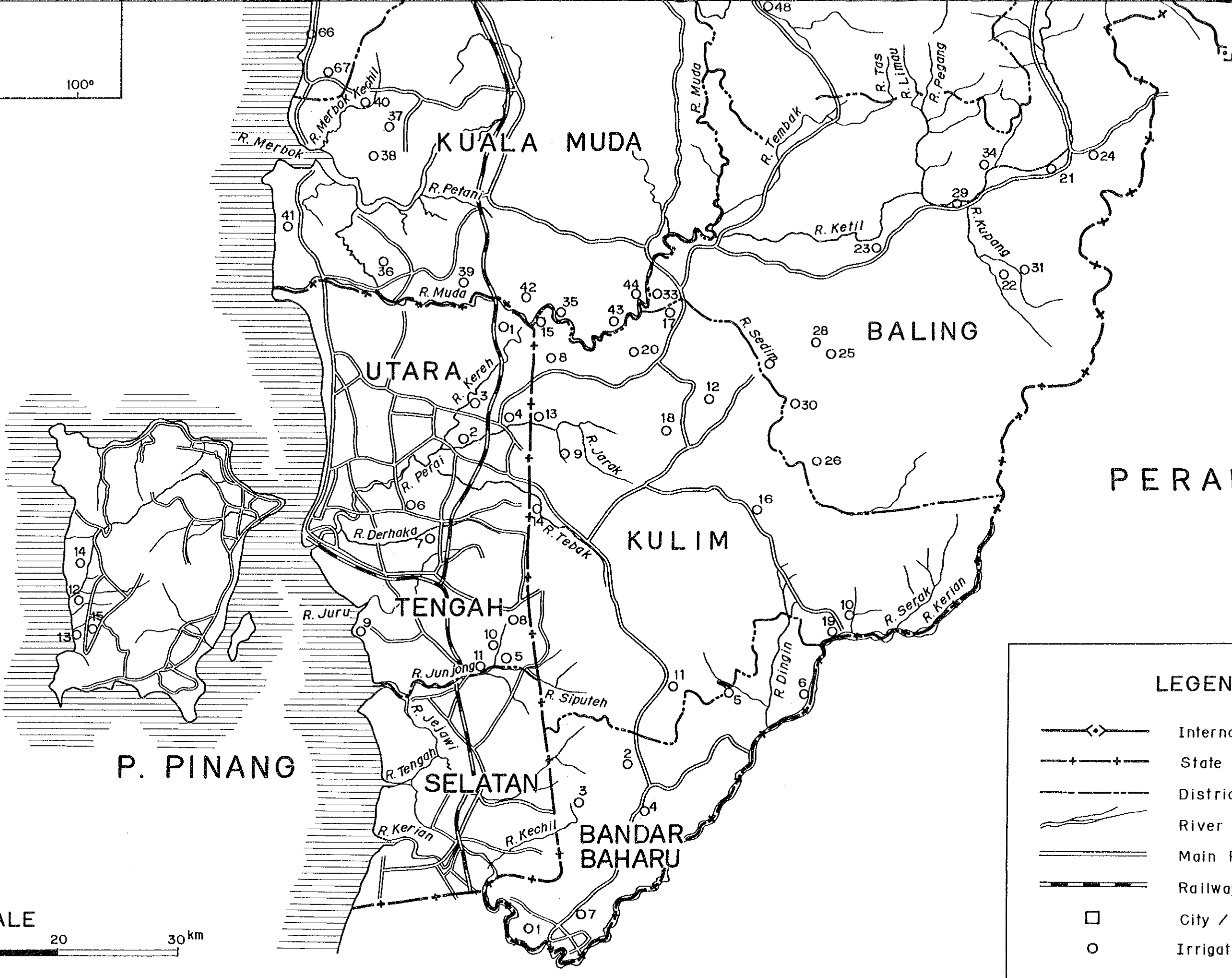
O31

P. BATANG BUNTING



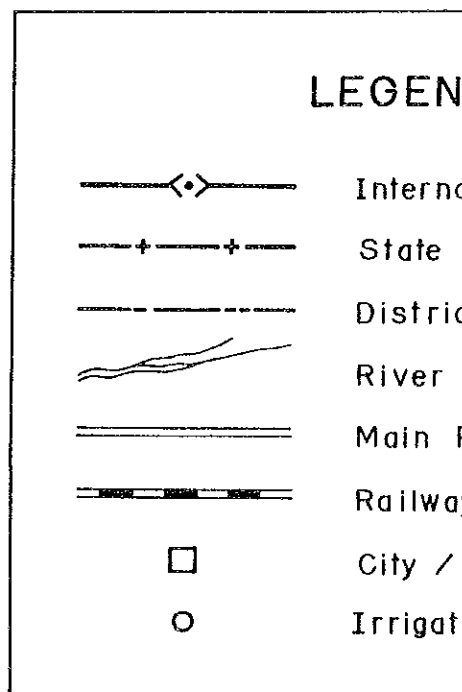
STRAIT OF MELAKA

5° 30'



PERAK

P. PINANG



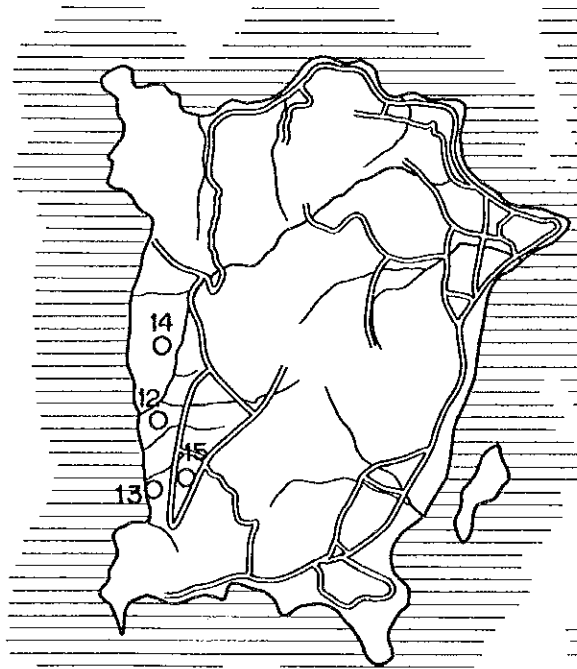
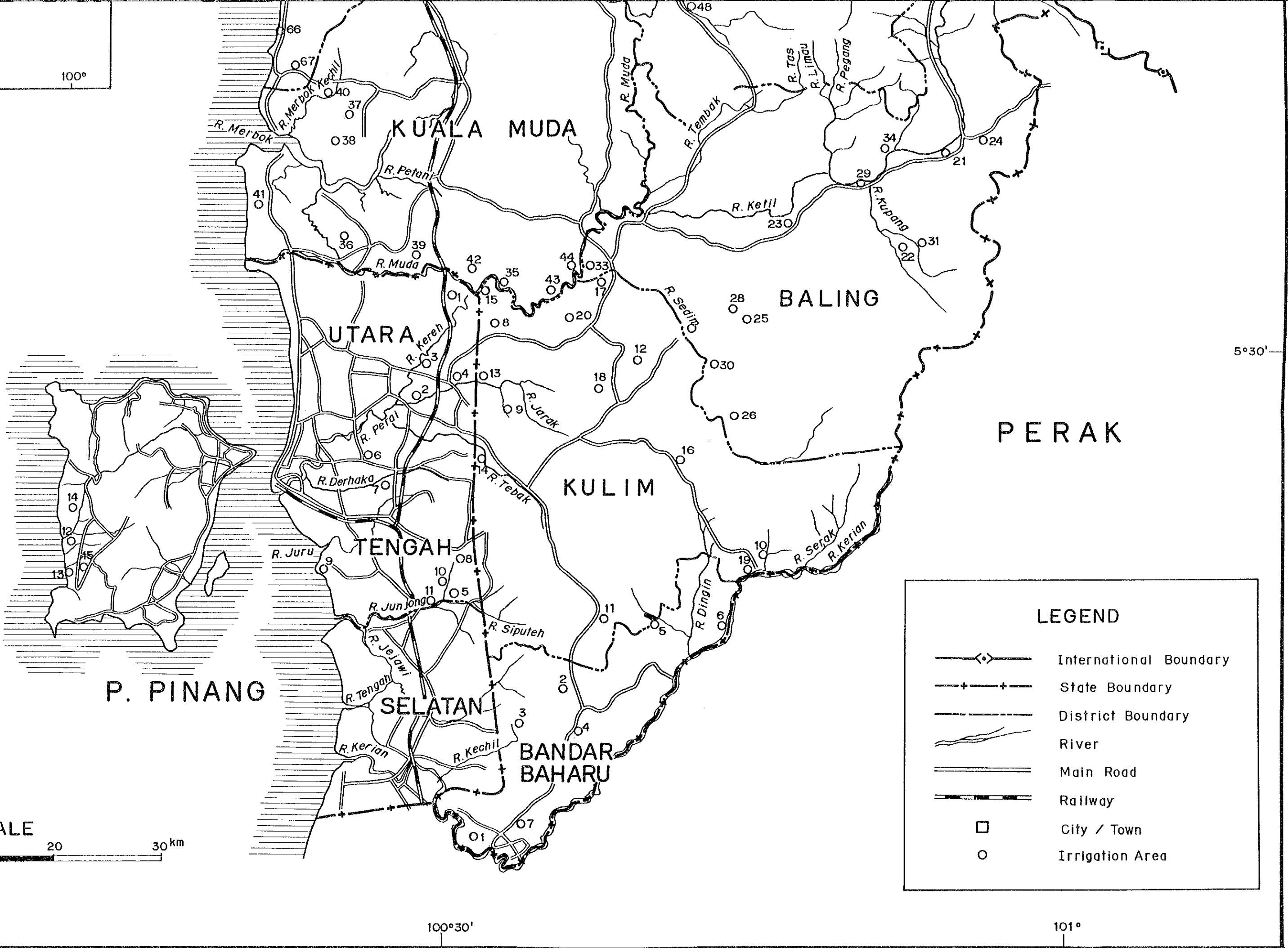
100°

100°30'

101°



SOUTH OF MELAKA

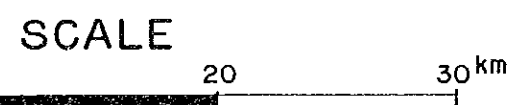


PERAK

5°30'

100°30'

101°



LEGEND

- International Boundary
- State Boundary
- District Boundary
- River
- Main Road
- Railway
- City / Town
- Irrigation Area

JICA